Malpais Mysteries

PARKS AS CLASSROOMS℠

4th Grade Curriculum

El Malpais National Monument

Acknowledgements

The creation of this guide was truly a team effort and could not have been done without the help and support of all those involved. Special thanks to Linda Cochran for developing most of the activites based on her many years of experience not only as a teacher, but also as a park ranger. Special thanks also to Calvin Chimoni for many of the drawings found in the activities.

Development and printing of this guide was made possible by a grant from the National Park Foundation.

Using This Guide

The objectives of this guide are to:

- Provide students with an active learning environment utilizing the resources preserved at El Malpais.
- Provide students with a sense of ownership and responsibility for public lands through interaction with park resources.
- Develop an effective educational tool which creatively integrates park resources with required teaching curricula.

The individual activities were selected to meet curriculum objectives of the Grants-Cibola County School District. An interdisciplinary approach was taken when creating the guide so the materials are easily integrated into varied subject skill areas.

Activities in this book can be used as is, or modified to fit your classroom needs. Many activities have worksheets, but do not necessarily rely on the worksheets. Most worksheets have a Think About It section that encourages students to do independent research, or to investigate topics further. Answer Keys are included only for those worksheets with specific answers. Hands on extensions are also included in some activities. The transparencies can be found on the inclosed CD. They are .pdf files and you will need to have Adobe Acrobat Reader installed on your computer to read them. If it is not already on your computer, it can be downloaded for free from Adobe. If you have problems with the transparencies, please call us.

While we would like each class to visit El Malpais, we understand that this is not always possible. This guide allows us to reach students who may not otherwise have the opportunity to visit the monument.

We hope that this guide is useful to you and helps connect you and your students to the mysteries of El Malpais National Monument!

Introduction

El Malpais was established as a national monument and added to the National Park System on December 31, 1987. The monument is comprised of approximately 114,000 acres. All of the land is located within Cibola County, New Mexico. The monument is located south of Interstate 40 and is bordered by NM Highway 117 on the east, NM Highway 53 on the west, and County Road 42 on the south. Comprised mostly of volcanic terrain, it contains some of the most recent lava flows in the continental United States.

This area contains ice caves, lava tubes, *kipukas*, spattercones, textbook examples of *pahoehoe* and *aa* lavas, and numerous other features associated with volcanic activity. In addition to the geological elements of the monument, numerous archaeological sites and other cultural resources are found at El Malpais. Extensive biological diversity exists among the lava beds. Researchers are only now beginning to explore the complex ecosystems which have developed within the lava flows.

The El Malpais Information Center is located 23 miles south of Grants on NM 53. The administrative headquarters is located at 123 East Roosevelt in Grants.

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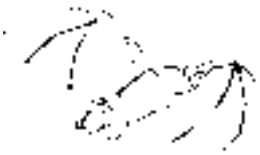
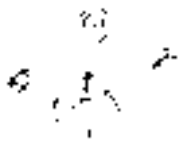
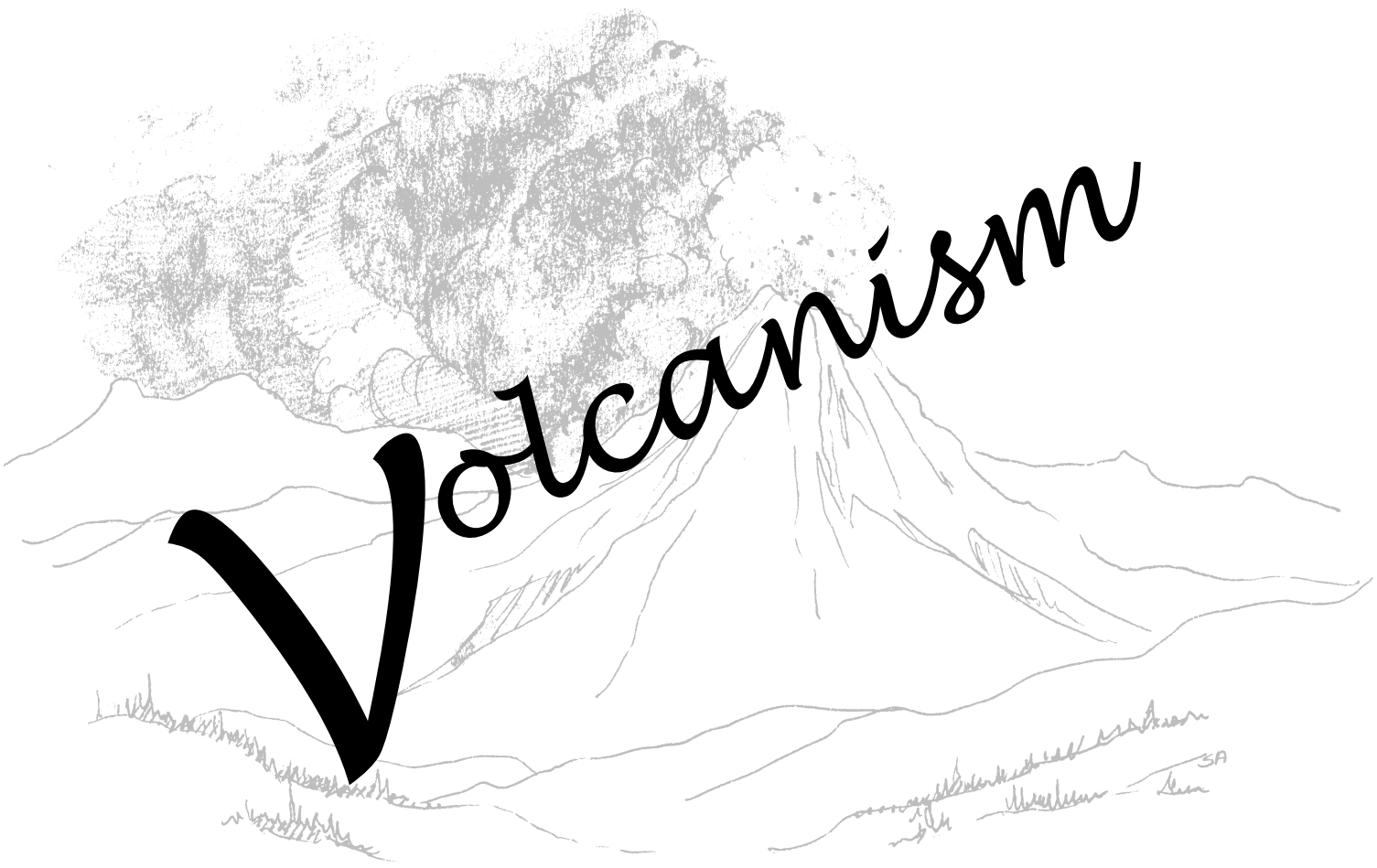





Volcanism

Volcanism at El Malpais

Volcanism is one of the most common and widespread processes that have shaped and modified the surface of the earth. Geologic change is usually measured in millions of years, but within days or sometimes even hours, the Earth's surface can be dramatically altered by an erupting volcano.

The present landscape of El Malpais National Monument is the result of numerous volcanic eruptions, small and large, over thousands of years. The most recent eruptions took place only a few thousand years ago.

El Calderon Flow

At 115,000 years old, the lava from El Calderon is some of the oldest in the monument. There were at least two cinder eruptions–the first one producing black cinders, the last dark red. There was also at least one high volume basaltic lava flow that created an extensive lava tube system. Much of this system was buried by the later Twin Craters Flows.

Junction Cave is part of the El Calderon lava tube system that remains unburied. At the breach of the El Calderon Cinder Cone, a deep volcanic trench can be seen.

Twin Craters Flow

This lava flow is over 16,000 years old, and was formed by eruptions during the same period from several different cones and fissures in the same area. These include La Tetra, a shield volcano with a collapsed crater of cinders called Lava Crater at its source; Cerro Candelaria, an eroded cinder cone; Twin Craters, vents along a fissure; and Lost Woman, a cinder cone.

Hoya de Cibola Flow

These flows are between 16,000 and 11,000 years old and originate from the Cerro Hoya vent and perhaps others that formed a low broad shield. The large collapse pit, or crater, called Hoya de Cibola is part of this shield. These lava flows traveled east-northeast and southeast. Much of these flows were later covered by the Bandera and McCartys flows. Braided Cave is part of the Cerro Hoya lava tube system that remained unburied.

Bandera Flow

Several flows originate from the 10,000 year old Bandera Crater. The first created the the cinder cone seen today. The later, high volume basaltic pahoehoe flows ended with the inner collapse of the emptied magma chamber under the crater. This made Bandera Crater deeper than usual. The Bandera flow is noted for its 17 mile long tube system, the longest in the continetal United States.

McCartys Flow

The source for this 3,000 year old flow is a shield volcano with a small cinder cone at its vent. McCartys Crater was partially destroyed by use as a bombing target during World War II. The flow is characterized by numerous large collapse depressions and is the youngest flow in this area.

Lava Flow Features

Aa–Hawiian term for lava flows that have a clinkery, rough or jagged surface.

Basalt–A dark-colored, find-grained lava rich in iron and magnesium and relatively poor in silica (less than 54 percent). Very fluid because of their low silica content, basaltic lavas can flow great distances from their source. Basalt is the most abundent lava on earth.

Blocky lava–Blocks formed when (non-viscous) fluid lava cooled and pressure behind it caused fracturing.

Cinders–Volcanic fragments, ranging in size from one-half inch to three inches, that fall to the ground in a solid condition.

Cinder cones–A type of volcano ranging in height from about 20 feet to 1,500 feet high or higher. Cinder cones are formed by the accumulation of cinders around a volcanic vent.

Collapses–Areas where the crust of the flow has fallen inward creating depressions.

Collapse sink–An essentially circular, usually steep-sided, surface depression resulting from collapse into an underlying cavity.

Collapse trench–An elongated, usually steep-sided surface depression resulting from the collapse of a lava tube roof.

Ice caves–Lava tube caves where no sunlight and little air flow allow ice to accumulate. Water freezes in winter inside the tube and doesn't thaw in the summer so ice gradually accumulates to form an ice cave. Some caves have ice year round, for others it is seasonal.

Kipukas–Hawiian term meaning "island" of land or older lava surrounded by younger flows.

Lava tube caves–Caves formed along a tube system when collapses occur that provide access to parts of the lava tube.

Lava tube system–A tube system forms as the outer crust of a lava flow hardens and the lava in the center continues to flow forming a cylindrical conduit that finally empties as the source flow ceases.

Pahoehoe lava–Hawiian term for relatively smooth surface or ropy textured lava.

Pressure ridges–Ridges of lava formed by lateral pressures, similar to creating a fold in a piece of paper by pushing in towards the middle from both sides; almost always has a large crack running down the crest.

Speleothem–A mineral deposit formed in a cave. The most abundant mineral deposited in lava tube caves is ice.

Spatter cones–Low, steep sided cone built by lava along a fissure or around a vent; typically range in size from a few feet hight to hundreds of feet high.

Squeeze-ups–Small mounds or ridges that have resulted from the extrusion of lava through a crack in the solidified crust.

Volcanic bombs–Rounded lava that has been thrown through the air by a volcano. Bombs range in size from one inch to three feet in diameter.

Xenolith–Fragments of the Earth's mantle that were brought to the surface by fast-rising magma and encased as the lava cooled; means "foreign rock."

Formation of Volcanos

Subjects:
science

Skills:
listening
categorizing

Materials:
worksheet
transparencies

Vocabulary Words:
magma
subduction zone
rift zone
hot spot
mantle
lava

Objectives

Students will identify three ways volcanos are formed.

Background

A deep, hot layer of rock called the **mantle** lies beneath the earth's crust. Some of this mantle is molten or melted. This hot, flowing rock is called **magma**. Tremendous pressure within the mantle forces the magma up to the surface where it erupts through the earth's crust.When magma reaches the earth's surface, it is caled **lava**.

Subduction zone volcanos are formed where the large, shifting plates of the earth's crust bump into each other and one plate falls below another. **Rift zone** volcanos form when the plates of the earth's crust split apart. **Hot spot** volcanos are formed where the magma rises and melts a hole through a plate of the earth's crust.

Suggested Procedure

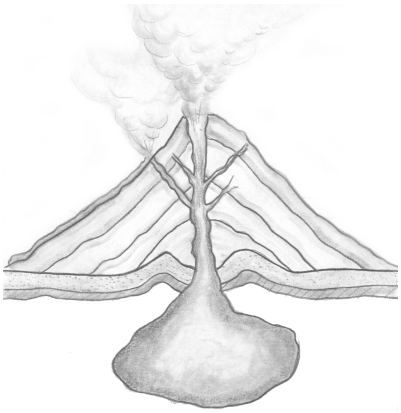
1. Using the transparencies, discuss the three ways that volcanos are formed.

2. Students can match characteristics to identify each type of volcano on their worksheets.

Name:
Date:

Formation of Volcanos

Using your knowledge of how volcanos are formed, label the pictures as either subduction zone, rift zone or hot spot volcanos.



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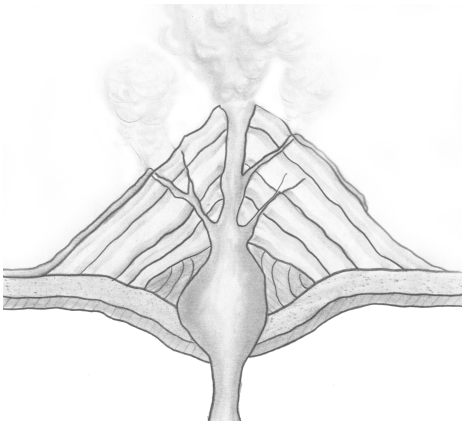

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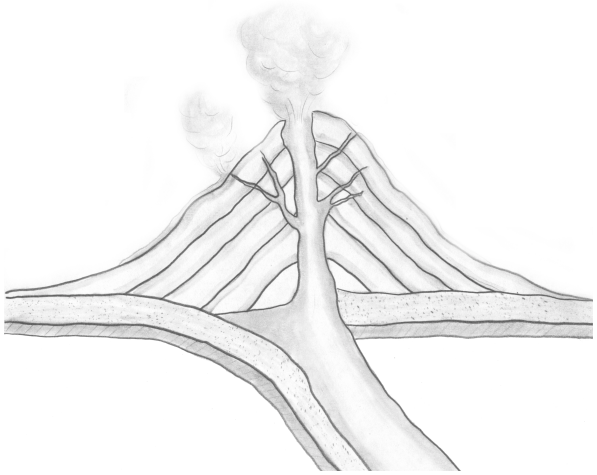

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Think About It

Using the library, research the following volcanos to see how they were formed:
Vesuvius
Mt. St. Helens
Mauna Loa
Mount Fuji

Types of Volcanos

Subjects:
science
language arts

Skills:
listening
group cooperation
library usage

Materials:
research materials

Vocabulary Words:
shield volcano
cinder cones
composite volcano
crater
caldera
basalt

Objectives:

Students will (1) research three types of volcanos (2) share knowledge about a volcano type with team members.

Background:

One kind of volcano is known as a **shield volcano**. Lava that comes from shield volcanos is **basalt**; it flows out quietly and spreads over a wide area. A shield volcano has a rounded or flat top and is made from multiple lava flows: examples at El Malpais are Cerro Rendija and Cerro Hoya.

Cinder cones are another kind of volcano, but are much smaller in size. They are made up largely of small pieces of lava, rather than sheets of lava. A cinder cone is really cone-shaped; often with a **crater** at the top. El Calderon is this type of volcano.

A **composite volcano** is formed by layers of ash, cinders, bombs, mud flows, and lava flows. Composite volcanos, also called stratovolcanos, are much larger than the others. They usually have a crater at the top. They may explode violently and form a caldera.

A **caldera** is a very large crater, which may be miles across, formed when the volcano collapses into the space once occupied by the magma and rock ejected by one or more gigantic explosions. Mt. Taylor is a composite volcano with a relatively small caldera. An example of a very large caldera is Valle Grande in the Jemez Mountains.

Suggested Procedure:

1. Divide students into teams.

2. Give each child a number one through three. Ones will research shield volcanos, twos cinder cones, threes composite volcanos. (Several students on a team may be researching the same kind of volcano.)

3. Allow time for students to gather information. It may require using the library.

4. Encourage students to make a visual aid to teach others on their team about their type of volcano.

5. Reassemble teams and have team members share what they have learned.

Extension:

Using sand and mud, studetns will make models to demonstrate three types of volcanoes found at El Malpais.

Materials:

bucket	funnel
sand	3 coke flats
fine soil for mud	plaster or Fix-All
sheet of plastic	balloon
water	wire

Suggested Procedure:

1. Line four boxes with plastic.

2. Cinder cone model: Pour sand through a funnel and let it collect in a symmetrical pile in the box. Do this several times and note the shapes of the piles.

3. Shield model: Mix a bucket of mud to the consistency of gravy and pour it on a sheet of plastic in the box. It will help if some Fix-All is added to improve the consistency and give the lava a distinctive color. Let it stand until it firms up, then pour another layer over the first. The formation will be more visible if a few drops of vegetable coloring are added to each layer. By carefully placing each pour, a shield formation should develop. It will help if the box has a layer of sand in it to absorb excess water.

4. Composite model: Pour out a small pile of sand. Then pour mud mixture containing plaster or Fix-All over it. When the mud sets, pour more sand and then more mud. Repeat until cone is built up.

5. Caldera model: Inflate a small balloon as much as possible without breaking it. Pour a pile of sand over it using the funnel to build a cone. Puncture the balloon using a long wire with a pin glued to the end.

Name:
Date:

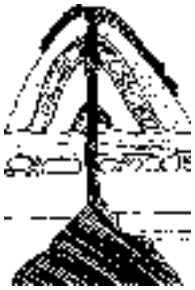
Types of Volcanos

The area around Grants has all three types of volcanoes you've learned about. They vary in age from about three million years old to about three thousand years old. From what you have learned, match the description on the left to the volcano on the right.

Volcano with layers of ash, cinders, bombs, mud flows and lava flows

Cinder Cone

Volcano with rounded or flat top. The lava flows quietly over a large area.



Composite Volcano

Volcano made up of small pieces of lava with a crater at the top.

Sheild Volcano

Think About It

Volcanologists (people who study volcanoes) say that anything that has erupted within the last 10,000 years has the potential to erupt again. Is it possible that volcanos could once again erupt in the Grants area? Why or why not?

On average, how many years have there been between eruptions at El Malpais? Look at **Volcanism of El Malpais** for dates.

What Comes Out of a Volcano?

Subjects:
science

Skills:
observing
comparing
classification

Materials:
worksheet

Vocabulary Words:
magma
pahoehoe
aa
pyroclastic
cinders
volcanic bombs
ash
viscous

Objectives:

The student will (1) identify three types of lava flows, (2) compare the lava flows to one another and (3) draw a conclusion about how these lava flows were formed.

Background:

There are three main types of volcanic flows: **pahoehoe**, **aa** and **pyroclastic**.

Pahoehoe (pronounced pa-hoy-hoy) has a ropy, coiled appearance; the surface is often smooth and easy to walk across. Pahoehoe flows are formed by slow moving lava flows. Pahoehoe flows are **viscous**, meaning they are thick and have little gas in them.

Aa (pronounced ah-ah) is rough and jagged with tiny spines. This type of lava can be very difficult to walk on. Aa flows are formed by fast moving lava flows. Aa flows are non-viscous flows and are gas rich.

Pyroclastic flows are combinations of gas, **ash** and rock that explode violently out of the volcano. **Cinder**, small pea-size pieces of lava, is a type of pyroclastic lava. Larger rocks, called **volcanic bombs**, are also a type of pyroclastic lava. Volcanic bombs come in many forms: blocks, pieces of ribbon, spindles, almond shape, flat or round; some have even been found wrapped around tree branches.

Suggested Procedure:

1. Using the transparencies, discuss the different types of lava flows with students.

2. Have students complete worksheet.

Extension:

Specimens of lava can be checked out from El Malpais (see appendex).

Suggested Procedure:

1. Group students in teams and give each team a set of lava rock specimens.

2. Instruct students to examine the specimens and make inferences about how the lava was formed. Write down these observations.

3. Share the observations with other groups and compare observations.

4. Ask students to illustrate a small poster showing the different types of lava flows at El Malpais.

Name:
Date:

What Comes out of a Volcano?

All three types of lava flows you have learned about can be found at El Malpais. Pick one type and illustrate it in the space provided. Write a brief description below your illustration.

Think About It

Why does lava take on so many forms? Why is aa so rough and pahoehoe so smooth? Why do lava bombs take on the shapes that they do?

Molten lava is about two thousand degrees Farenhiet. How does this comapre to the temperature that water boils or a hot summer day? How does it compare to the temperature of the sun?

Lava Tube Formation

Subjects:
science
art
language arts

Skills:
Sequencing
Comparing

Materials:
worksheet
transparency

Vocabulary Words:
lava tube caves
collapses
viscosity

Objectives:

The student will be able to (1) identify the stages of lava tube formation (2) assemble pictures in their correct order.

Background:

After the crust has formed on **viscous** pahoehoe type lava, the interior may remain liquid and mobile for a long period of time. As the main body of lava cools, the flow is restricted to a mobile cylinder in the thickest and hottest part of the flow. The lava will recede in the tube leaving lava benches or "water marks" along the sides of the tube many feet in diameter. **Lava tube caves** may extend for several miles, but there are collapse areas at intervals which expose the tube and provide means of access. In some cases **collapses** will occur in such a way that bridges are formed.

Suggested Procedure:

1. Discuss how lava tubes are formed using the transparency.

2. Students can cut out pictures from their worksheet and put them in their correct order.

3. Have students write a narrative to each picture explaining the process of lava tube development.

Extension:

To help students understand the conditions that must exist for lava tubes to develop (lava usually flows quickly indicating a viscous, pahoehoe flow), have them compare the viscosity of different liquids. This can be done by the class as a whole, or in groups.

Materials:

stopwatch
pudding
gravy
syrup
glue
mixing cups
measuring spoon
paint tray

Suggested procedure:

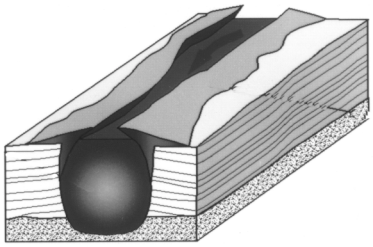
1. Place equal amounts of each liquid (one at a time) at the top of the paint tray.

2. Using a stopwatch, time how long it takes for each to reach the bottom of the tray. The slower the liquid, the more viscous it is.

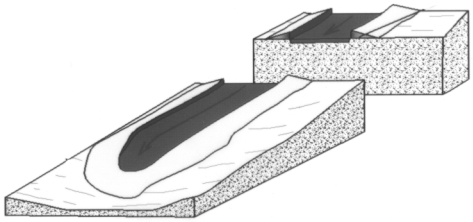
Name:
Date:

Lava Tube Formation

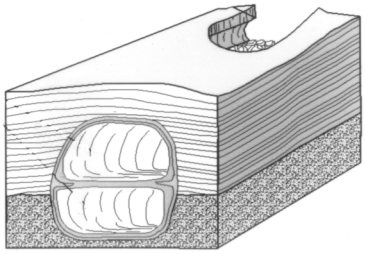
Cut out the pictures and paste them in correct order.



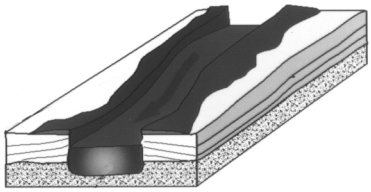
The roof of the tube forms as hardened lava builds up and over the hot flowing lava.



Lava flows from the volcano like a river or stream.



Over time, the roof may collapse and form trenches. This also allows access into lava tubes.



The lava begins to erode into underlying soil, volcanic cinders and older lava.

Think About it

Lava tubes form when the lava is less viscous (runny). Why don't lava tubes form when lava is more viscous (thick)? It may help to look at the viscosity of several liquids before answering this question.

There are over 200 known lava tube caves at El Malpias. Knowing what you do about lava flows, would you be more likely to find lava tubes on aa flows or pahoehoe flows? Why?

To Be A Volcano

Subjects:
science
language arts

Skills:
creative writing

Materials:
none

Objectives:

Students will be able to use knowledge of volcanos to write a story.

Background:

Many people think volcanos are a thing of the past. Not true! Volcanos are still erupting in many places around the world. The awesome power of an erupting volcano can still be witnessed and studied.

Suggested Procedure:

1. Get students to think about the forces involved in an erupting volcano. Ask questions like: What would it be like to see a volcano erupt? How would it feel to be inside of an erupting volcano?

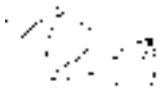
2. Have students write a short story or poem about one of the volcanoes at El Malpais when it erupted. Trying writing it from the view point of the volcano.

Extension:

Students can illustrate and share their stories with classmates by publishing them in book form.

Biodiversity

Biodiversity at El Malpais



The volcanic features of El Malpais provide a variety of habitats for plants and animals. The culmination of this area's geology, soil, climate, precipitation, temperature and historic land use have created a diverse ecosystem that is now preserved in the national monument.

A vegetation and wildlife inventory of the monument was completed in 1994 by biological researchers from the University of New Mexico. Their findings indicate that plant and animal communities are associated with major geological features and often do not fit standard vegetation classifications. In examining ecosystem diversity, researchers identified typical communities found in this region and also located some ecosystems unique to El Malpais.

Ponderosa Pine/Douglas Fir forest

This community is mixed conifer forest composed of large trees with dense canopy foliage and poorly developed understory vegetation. Typical animal species are those associated with dense coniferous forests. Residents include: Ponderosa Pine, Douglas Fir, Aspen, Black Bear, Deer Mice, Elk, Northern Goshawk, Tassel-eared Squirrels and Red Crossbills.

Mid-low elevation Ponderosa Pine woodland

This community is a Ponderosa Pine parkland, with a well developed grass understory. It occurs on and off of lava flows, and on cinder cones. These areas vary from dense Ponderosa Pine forest to more open Ponderosa Pine and Piñon Pine woodlands. Residents include: Ponderosa Pine, One-seed Juniper, Colorado Piñon, Rocky Mt. Juniper, Gambel Oak, Mountain Muhly, Western Wheatgrass, Blue Gama, Mule Deer, chipmunks, Wild Turkey, Common Flickers and Sharp-Shinned hawks.

Piñon-Juniper woodland

This community is dense to open Piñon/Juniper woodland, and is found at all elevations at El Malpais. Residents include: Colorado Piñon, Piñon, One-seed Juniper, Rabbtibrush, Snakeweed, Blue Gama, Desert Cottontail, Coyote, Mice, Gopher Snake, Eastern Fence Lizard, Mountain Bluebird, Piñon Jay and Townsend's Solitaire.

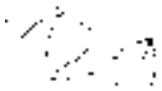
Juniper savanna

This community is generally found on the landscapes surrounding the newer lava flows where fine loam or silty soils are found. Residents include: One-seed Juniper, Blue Grama, Colorado Pine, Snakeweed, Rabbitbrush, Pronghorn Antelope, Wolf-Tail Vesper Sparrow, Silky Pocket Mouse, American Kestrel, Whitetail Prairie Dog and Northern Harrier.

Sand Dunes and Sandy Areas

This community consists of old stabilized sand dunes, and other eolian sand deposits on the east side of the monument. Extensive sand and dune habitats are found at the north end of Sandstone Bluffs and the west side of North Pasture. Residents include: Lesser Earless Lizard, Ord's Kangaroo Rat, Wolf Spider, Camel Cricket, Grasshopper, Scorpion, Western Diamondback, Roadrunner and Millipede.

Habitat Sweet Habitat



Subjects:
science
language arts

Skills:
writing
creative thinking

Materials:
worksheet

Vocabulary Words:
habitat
species

Objective:

Students will be able to list the four elements of habitat.

Background:

Habitat contains everything a **species** needs to survive. Food, water, shelter and space are the four elements all species need to survive. These elements must be in a suitable arrangement for that particular species. For example, a bear needs more space than a squirel.

If one of these elements is taken away, or dramatically changed, the habitat is no longer suitable. The animal will have to find a new habitat or it will die.

Suggested Procedure:

1. Discuss habitat with students. You may want to list several different types of animals on the board and what their habitat is like.

2. Tell students that due to urban developments many animals no longer have suitable amount of space and must find new homes.

3. Have students write a classified add describing the perfect habitat for an animal found at El Malpais (see Biodiversity list). Students can also write their classified from the view point of an animal looking for a new home.

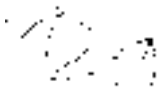
Name:
Date:

Habitat Sweet Habitat

Write a classified ad for a newspaper that describes the perfect home for a particular animal. You should make sure that your ad describes the four elements of habitat for that particular animal. You may also want to write an ad from the view point of an animal looking for a new home.

Example: Space in a dead and down tree available. Perfect for a family of beetles. Dark and damp with plenty of decaying vegetation to eat. Call Bert's Beetle Bungalos at 1-800-GO4-BUGS to find out more!

The Tangled Web of Life



Subjects:
science

Skills:
classifying

Materials:
word cards
ball of string

Vocabulary Words:
ecosystem
interdependence
adapt

This activity was adapted, with permission, from *Sharing Nature with Children* by Joseph Cornell

Objectives:

Students will be able to draw conclusions about the importance of interdependence in an ecosystem.

Background:

All living things in a natural environment are **interdependent** on one another. When something outside this environment is introduced (fire, logging, grazing, etc.) or taken away (predators such as coyotes, wolves) that community is altered or changed forever. Scientists have studied animals and plants to find out what happens when an animal leaves an **ecosystem** and also what happens when new animals/organisms are introduced into a new ecosystem. Sometimes an organism may do well and fit in (**adapt**) or it may not fit in and be forced to leave or die. The same holds true for the existing organisms in the ecosystem, they may adapt and make room for the new neighbor or be forced to leave or die out.

Suggested Procedure:

1. Have each child make an ecosystem card. Using index cards, each child will draw a picture of a particular animal on one side and copy the information about that animal on the other side of the card. The student will represent some part of the ecosystem. Depending on the size of the group, some animals may be repeated.

2. Have the students form a circle. Stand inside the circle near the edge with a ball of string.

3. Have one of the students step forward. Give that child the end of the string. Ask if someone in the ecosystem eats or need this. Continue connecting the children with string as their relationships to the rest of the group emerge.

4. Take away some member of the web, explaining that the tree it depended on for survival was cut down. When the tree falls, the child tugs on the string. Anyone who feels a tug on his/her string is in some way affected by the death of the tree. Now everyone who felt a tug, gives a tug. The process continues until every individual is shown to be affected by the death of the tree.

Extension

Have students make a poster showing all the parts of an ecosystem for a particular animal or plant found at El Malpais. They may need to do research to find out where it lives, what it eats, who its predetors are, etc.

Name:
Date:

The Tangled Web of LIfe

Pick an animal (each animal should be represented) and make an ecosystem card using the information below.

Common Raven
Characteristics:
large, black bird with large bill
"caw" has gargled sound
Food:
carrion, rodents, small mammals, insects, reptiles, variety of plantlife
Habitat:
wooded foothills, mountains

Elk
Characteristics:
reddish-brown with a pale yellow rump
dark brown hair on neck
Food:
vegetarian diet of grass
Habitat:
mountain meadows, forested areas in summer and valleys in winter

Striped Skunk
Characteristics:
house cat size, bushy tail
black body with white stripe
Food:
carrion, insects and small mammals
Habitat:
woodlands, bushy areas, grasslands, burows

Rattlesnake
Characteristics:
coils and rattles tail at intrusion
rattle at end of tail, gray or brown
Food:
mostly rodents, small mammals
Habitat:
rocky canyons, grasslands

Desert Cottontail Rabbit
Characteristics:
pure white undersides of tail
gray back, large ears
Food:
vegetarian diet
Habitat:
variety of habitats where brush cover is available

Mule Deer
Characteristics:
large ears, white rump
runs or bounces on all fours
Food:
prefers leaves and twigs
Habitat:
desert shrublands to coniferous forests

Raccoon
Characteristics:
black mask, ringed tail
washes its food in water
Food:
omniverous; especially likes plants, nuts, crayfish
Habitat:
rough canyons, wooded areas always near water

Badger
Characteristics:
short legs, stout front claws
flat body
Food:
large rodents
Habitat:
treeless terrain, deep soil

Black Bear

Characteristics:
brown, black or cinnamon
heavily built
climbs trees, swims
Food:
fruit, nuts, vegetation, insects
meat, garbage
Habitat:
forests and woodlands

Pallid Bat

Characteristics:
sandy color;large ears, wings
Food:
insects, beetles, grasshoppers
Habitat:
low deserts to high mountains
dry areas with rocky outcrops

Rock Squirrel

Characteristics:
front half of body is gray
back half is red or brown
long bushy tail
Food:
mainly vegetarian diet, but will eat
eggs, young birds
Habitat:
canyons, rocky terrain

Mountail Lion

Characteristics:
tawny coat, light colored belly
long, cylindrical tail
Food:
mainly deer; small mammals
Habitat:
rimrock where desert ends and
forest begins, needs cover for stalking

Spadefoot Toad

Characteristics:
warty, rough skin; hops or walks
buries itself as water pools dry up
Food:
insects
Habitat:
deserts to desert grasslands

Gray Fox

Characteristics:
big ears, large busy tail
silvery-gray back
black streak on back and tip of tail
Food:
mainly rodents, insects, small invertebrates
fruits, vegetables
Habitat:
open forests, brushy woodlands
rocky canyons

Coytoe

Characteristics:
very dog-like, pointed muzzle
bushy, black tipped tail
Food:
small animals, carrion, roots and fruit
Habitat:
throughout most of North America in
every zone, all terrain

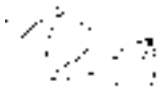
Red-tailed Hawk

Characteristics:
large hawk
reddish-colored tail seen in flight
Food:
rodents, small mammals, birds and snakes
Habitat:
deserts, grasslands, woodlands, mountains

Meadow Vole

Characteristics:
grayish-brown color, long tail
Food:
bark, grasses, roots
Habitat:
low grasslands

Ears in the Dark



Subjects:
science

Skills:
problem solving

Materials:
construction paper
cardboard
tagboard, etc.

Vocabulary Words:
echolocation
hypothesis
control

Objectives:

Students will be able to compare hypotheses about how bats echolocate.

Background:

Visual orientation is the perception and interpretation of light energy as it is reflected. This interpretation yields information about size, shape, color, texture and movement. Hearing is the perception and interpretation of sound energy as it is reflected. Information about size, shape, texture and movement can be perceived by audition (hearing). Acoustic orientation is by sound generated and emitted by an organism. Sound strikes an object and is bounced back yielding information concerning size, shape, texture and movement. Bats **echolocate** by producing a series of short pulses of high frequency sound. These are emitted through the mouth or nostrils. As these sounds travel through air, they spread out in the form of a cone. When this sound strikes an object, it is reflected as an echo. From these echoes a bat determines the presence, distance, direction and velocity of movement, size, shape and texture of the object. The bat can maneuver to avoid obstacles as well as identify, track and intercept flying prey. Bats are able to form a sonic image of their immediate environment.

In 1793, an Italian scientist, Lazzaro Spallanzani learned that owls became nearly helpless and unable to fly in a totally darkened room. Bats on the other hand could fly in a darkened room. This led to a number of experiments in which he learned that bats did not appear to rely on their visual sense to fly at night.

One of his first experiments was to place a light proof hood over the heads of his bats to block their vision. The bats were unable to navigate a darkened room. Next he used a transparent hood and found his bats were still unable to fly. To settle the matter of visual orientation, Spallanzani surgically blinded some bats. To his amazement, these bats were as capable as normal unblinded bats. He continued to conduct experiments plugging the ears of bats. Bats with plugged ears could not navigate. Spallanzani was unable to explain the results of his experiments and it would be another hundred years before they would be fully understood.

Suggested Procedure:

1. Pass out the copy of Spallanzani's experiment. Allow time for students to read it.

2. Discuss what a **hypothesis** is and how experiments are designed to test hypotheses.

3. Ask students to think of ways Spallanzani could have tested his hypothesis.

4. Introduce the students to the concept of a **control** in experimentation.

Extension

Instruct students to design a "sound-enhancer" so humans can hear better. They may use construction paper, cardboard, etc.

Name:
Date:

Ears in the Dark

In 1793, long before computers and many other kinds of sophisticated equipment were invented, an Italian scientist named Lazzaro Spallanzani (SPAH-luhn-ZAH-nee) began an experiment. He wanted to find out how nocturnal creatures were able to get around in the dark. By bringing owls into his lab and releasing them in the dark, he learned that they were expert nighttime flyers—as long as there was some light present. But they couldn't fly in complete darkness. On the other hand, he found that insect-eating bats had no trouble zipping about in complete darkness. Unlike the owls he had studied, the bats could avoid obstacles and snatch up prey (insects) without any light present at all.

1. If you were Lazzaro Spallanzani, what conclusions would you make from these observations?

_____
_____
_____
_____
_____

2. Come up with a hypothesis that would explain your conclusions.

_____
_____
_____
_____
_____

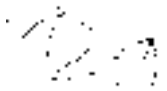
3. How could you test your hypotheses to see if your ideas were correct?

_____
_____
_____
_____
_____

Think About It

Not all bats can echolocate. The flying foxes and fruit eating bats use sight and smell to find their food. From looking at the two bat pictures, can you tell which is the insect eating bat (can echolocate) and which is the fruit eating bat (can't echolocate)? How can you tell the difference? You may have to do some research in the library.

Stealth Lizards



Subjects:
science
art
math

Skills:
psychomotor
comparing
generalization
observing

Materials:
worksheet
paper bags

Vocabulary Words:
pigmentation
melanism
predators
species

Objectives:

Students will be able to identify characteristics of adaptation and camouflage in animal species

Background:

Melanism is the genetic change in a species' skin color to a dark **pigmentation**. (This is the opposite of albinism.) A **species'** ability to blend in with its surroundings may be its only defense against predators. Many animals have coloration which matches their habitat. Some have stripes or dots which enable them to look like a part of the landscape. Melanistic species have evolved over generations to change their pigmentation. A few lizards found on the lava flows of El Malpais exhibit this trait. The lizards are much darker, harder to find and more apt to survive **predators**.

Suggested Procedure:

1. Explain to students that a species' color is an element of its survival.

2. Pass out the patterns of the "stealth lizard". Instruct students to color their lizard to match something in the room (the wall, a book, a desk, etc.). They should try to make color matches as close as possible. Have the students cut out their lizards. (Do not share with others what color your lizard is.)

3. Choose 5-8 students to be Red-tailed hawks. Give them small paper bags (these are their stomachs). Have these students leave the room.

4. Remaining students should hide their lizards, matching their background color.

5. Explain to the "hawks" that they have 30 seconds to feed.

6. After feeding count how many lizards were eaten, not eaten. Compute percentages.

7. Repeat the exercise. Choose another 5-8 students to be hawks. Instead of matching background color, hide the lizards anywhere.

8. Bring in the hawks. Allow them to feed for 30 seconds.

9. After feeding count how many lizards were eaten, not eaten. Compute percentages.

10. Make a graph comparing the results of both activities.

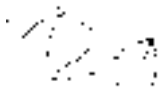
Name:
Date:

Stealth Lizards

Think About It

Compare how many lizards were eaten the first time to how many were eaten the second time. Compare percentages. Was there a difference? How would this affect a species population in the wild?

Life in the Dark



Subjects:
science

Materials:
worksheet
transparency

Vocabulary Words:
habitat
adapt
trogloxenes
troglophiles
troglobites
impacts

Objectives:

Students will be able to identify the three types of life found in lava tube caves.

Background:

Lava tubes create **habitats** for many species. Those species that spend the most amount of time in the cave have, over thousands of years, **adapted** to the special cave environment. The species found in caves are divided into three main catergories. **Trogloxenes** are animals that live above ground, but sometimes use the cave for temporary shelter. Examples include bats, mice, moths and even people. **Troglophiles** are another type of cave life, but unlike trogloxenes, troglophiles may live their entire life in the cave. They are not specifically adapted to the cave environment and you may find the same species living outside of the cave. Examples include earthworms, beetles, spiders and crickets. **Troglobites** are the last type of cave life and they are specifically adapted to the dark cave enviroment. They could not survive outside of the cave. Examples include mites, worms, crickets or other life that has changed significantly from the species found above ground.

Adverse **impacts** can affect the life inside of caves. These impacts may only cause a minor inconvenience for some species, but may cause major disturbances to other species. Some impacts may cause the elimination of some species that are completely dependent on the cave for survival.

Suggested Procedure:

1. Introduce the concept of adaptation.

2. Using the transparency, explain the different types of cave life.

3. Have students complete the worksheet.

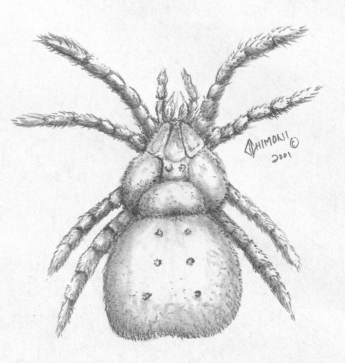
Extension:

Have students make Cave Creatures that have adapted to life in total darkness. Students may use a variety of arts and crafts supplies to make their creatures. They should consider what their creature will eat and how it will find its food; does it have any preditors; how does it find its way around in the dark cave. Students should be very creative. Their creatures do not have to be something found in real life.

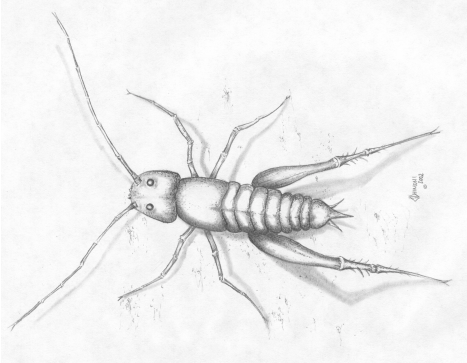
Name:
Date:

Life in the Dark

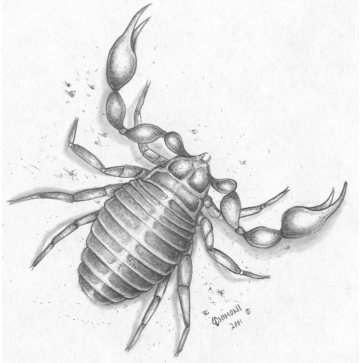
From the despcription, label each species as either a Trogloxene, Troglophile or Troglobite.



Mite - lives its entire life in the cave and is completely dependent on the cave for survival.

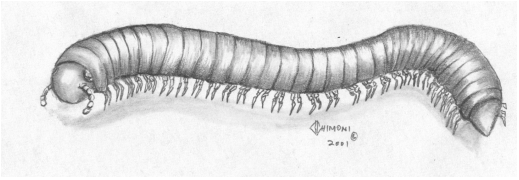


Cricket - lives in the darkest area of the cave and has become highly specialized to survive in complete darkness.



Psuedoscorpion - makes its home in the cave, but is not adapted to the cave environment.

Bat - roosts in the cave during the day, but must leave the cave at night to search for food and water.



Millipede - lives in the cave, but you may find ones just like it on the surface.

Think About It

Which type of cave life do you think would be most affected by impacts on the cave environment? Why?


Cultural
CH
istory

Cultural History of El Malpais

For over 10,000 years, man has occupied the land in and around the lava flows known today as El Malpais. Over time, cultures have been influenced by the beauty and mystery of the lava flows.

While archaeological evidence proves Paleo-Indians camped in the Malpais area, it wasn't until the Puebloan ancestor presence that permanent structures were built. This group of ancient Americans began with pit houses and ended with complex, multi-story structures.

It is believed that the Puebloan ancestors occupied the fringes of the lava from A.D. 300 through 1250. They were hunters and gatherers and gradually moved to an agrarian way of life. Farming enabled these people to spend more time on improving living conditions as they did not have to be constantly on the move to find food. The presence of kivas indicate that religion was an important element of Puebloan ancestor life.

While they did not live directly on the flows, the Puebloan ancestors utilized resources from the lava flows. What are believed to be ancient bridges (crevices filled with rocks to allow passage to the other side) are not uncommon. Rock cairns marking ancient routes are found scattered across the lava flows.

Many of the communities were associated with the much larger Chaco Canyon complex. Archaeologists refer to these small villages as Chacoan outliers. Literally hundreds of outliers are scattered throughout the Four Corners area. Their connection to Chaco Canyon is yet to be answered.

Archaeological evidence does show that the Puebloan ancestors left their communities and villages about 1250. Why and where did they go? Some probably migrated east to present day Acoma. Others went west to Zuni. Both of these pueblos retain close ties to the lava flows. An ancient trail across the lava became an important link between the two pueblos.

The Spanish had their first contact with the inhospitable lava flows in 1540, while searching for the fabled Seven Cities of Gold. They gave it the name "malpais" (badlands) and made every effort to avoid it. An expedition under the leadership of two Franciscan friars, Dominquez and Escalante, may have skirted the lava beds at some point in 1776. There is no concrete evidence that they actually crossed the lava flows.

Spanish occupations of land around the lava flows was gradual, but by the 1800's numerous sheep herders moved into the area. Little changed under Mexican rule in 1821.

Following the Mexican War of 1846, and the Gadsen Purchase Treaty, the United States had fulfilled its "Manifest Destiny" and claimed all the land from the Atlantic to the Pacific. Plans were made to survey these new territories. An important discovery in California, gold, probably accelerated those plans.

In 1849, an army survey party commanded by Lt. Simpson did some of the first accurate mapping of landmarks around El Malpais. Their mission was to find a new wagon road to California along a more

southerly route. This road, later built by Lt. Beale and his camel corp, followed the Rio Grande to Albuquerque, probably crossed the river near present day Los Lunas, passed near Laguna Pueblo, and through Villa de Cubero. Exactly where it crossed the lava flows is not known. According to the journal of John Udell, a member of the first wagon train to use this new route, the lava was very hard on animals and wagons.

The new road to California was never heavily used because by 1882, the railroad came. The tracks crossed the northern portions of the flows. With the railroad came increased settlement and the occasional train robbery. Rumors exist to this day of hidden gold somewhere in El Malpais.

French-Basque sheepherders grazed their flocks along the fringes of the lava flows and in accessible kipukas well into the 20th century. Ponderosa pines were heavily logged in and around the edges of the flows. Bat guano found in some lava tubes was mined commercially for a while. Even ice found in some caves was harvested.

The late 1920s and early 30s brought a new kind of immigrant to the area, the homesteader. This was one of the last areas in the United States, outside of Alaska, to remain open to homesteading. Farmers who had lost their homes and land to the Dust Bowl came out here seeking a new start. The homesteaders built along the fringes of the lava flows.

It could not have been an easy life. Lack of water was always a problem, no electricity and miles of dirt roads to the nearest town made daily life challenging. By the 1950s, most of these homesteads were abandoned or absorbed into larger ranches. This also coincided with the discovery of uranium northwest of Grants.

The economic fortunes of the Grants area, dependent on the uranium industry, went through a series of boom and bust cycles. In 1983, all but one uranium mine shut down. Cibola County began is look to tourism to build a new economic base.

Efforts to interest the National Park Service in the Malpais begin in the thirties. Some felt the Ice Cave was deserving of national monument status. The Park Service was not interested. The Candelarias developed the Ice Cave area into a tourist attraction. On the east side of the Malpais, Mark and Ina Elkins and Artie Bibo established the Kowina Foundation to honor the western pioneers and the heritage of the Acoma Indians.

The Park Service began to show an interest in the Malpais during the 1970s. However, a bill introduced by Harold Runnels in 1973 to establish a national monument failed. The idea wouldn't die and on December 31, 1987, El Malpais National Monument was officially created.

Trash Can Archaeology

Subjects:
science
social studies
language arts
math

Skills:
sorting
observing

Materials:
markers
poster board
trash

Vocabulary Words:
stratigraphy
archaeology

Objectives:

The students will (1) interpret materials found in wastebaskets (2) categorize the materials according to origin and (3) demonstrate that they understand the principle of stratigraphy.

Background:

Archaeology is the study of physical evidence to determine how people lived, what tools they used, etc. While careful measurements and exact documentation is vital to a scientific exploration, archaeologists can only speculate on why and how, based on their own experiences and knowledge. This is especially true when examining the remains of prehistoric inhabitation.

Prehistoric people did not have garbage cans in which to throw their discarded items. Usually they threw them into heaps or into pits under houses. Some archaeologists study modern trash and compare it to prehistoric trash to better understand what people use and discard.

Stratigraphy refers to the interpretation of layers of past cultural deposits. The youngest is usually on the top, with the oldest on the bottom. If layers are disturbed, sometimes as a result of vandalism, then correct interpretation is impossible. By examining and analyzing the layers and artifacts found in those layers, archaeologists can learn how past peoples lived.

Suggested Procedure:

1. Preselect wastebaskets from various rooms. (Arrangements should be made the day before so the trash can is full.)

2. Before examining the contents of the trash can, the class should agree upon categories for their finds, i.e. paper, plastic, wood, etc.

3. Give each team a trash can. Have them measure its height and divide it by three. Some fractions may be involved.

4. Draw a representation of the trash can on the poster board.

5. Instruct each group to remove the trash one third at a time and carefully document what is in each layer. Draw what is found at each layer on the poster board.

6. Students should speculate on the age of the children using the trash can, types of activities, time of day for each layer, finally where the trash can originated (grade level, teacher, etc.)

7. Guide students into a discussion of things they can not determine about the people who used these trash cans. (For example color of hair, height, what kind of clothes they were wearing, etc.)

Extension:

Have each team prepare a graph comparing the types of trash by number.

When Clay Sings

Subjects:
literature
science
social studies
art

Skills:
listening
making inferences
creative thinking

Materials:
worksheet

Vocabulary Words:
pottery sherds
artifacts

Objective:

The student will be able to list ways archaeologists use pottery sherds to learn about the Puebloan ancestor culture and create a pottery design.

Background:

Pottery sherds are commonly found around the edges of the lava flows at El Malpais. Archaeologists use these **artifacts** as an indicator of Puebloan ancestor occupation and to date the time of that occupation. The sherds are a very important part of the Puebloan ancestor story and tell much about their culture. Since these pot sherds are lying on the ground surface they are vulnerable to theft. Even though they are small, they are an important link to the past.

Suggested Procedure:

1. Explain to students how difficult it is for an archaeologist to get a complete story about a culture if parts of that story are missing. Remind students how important it is to leave artifacts where they are found.

2. To demonstrate how an archaeologist pieces together pottery sherds, have students color, then cut the picture of a pot into 10 pieces (like a jigsaw puzzle). Remove one or two pieces because archaeologists probably would not be able to find all the pieces of a pot and give the rest to a classmate and have him/her put it back together.

Extension

When Clay Sings by Byrd Baylor is included with this guide.

Suggested Procedure

1. Read *When Clay Sings* to the class.

2. Ask questions about the story. Examples:
Is the story talking about American Indians of today or long ago?
What are some of the things the pieces of clay sing about?
What are the colors of the clay? Where do these colors come from?

3. Discuss archaeology. Explain that the pieces of clay are called artifacts. By studying artifacts, archaeologists learn about the cultures of the people who used them.

Extend this lesson by having students make clay pots using the simple coil method. The outside can be smoothed or left as is. Draw designs on the pot and color them with tempera paint. Use black, red or orange.

Play Clay Recipe

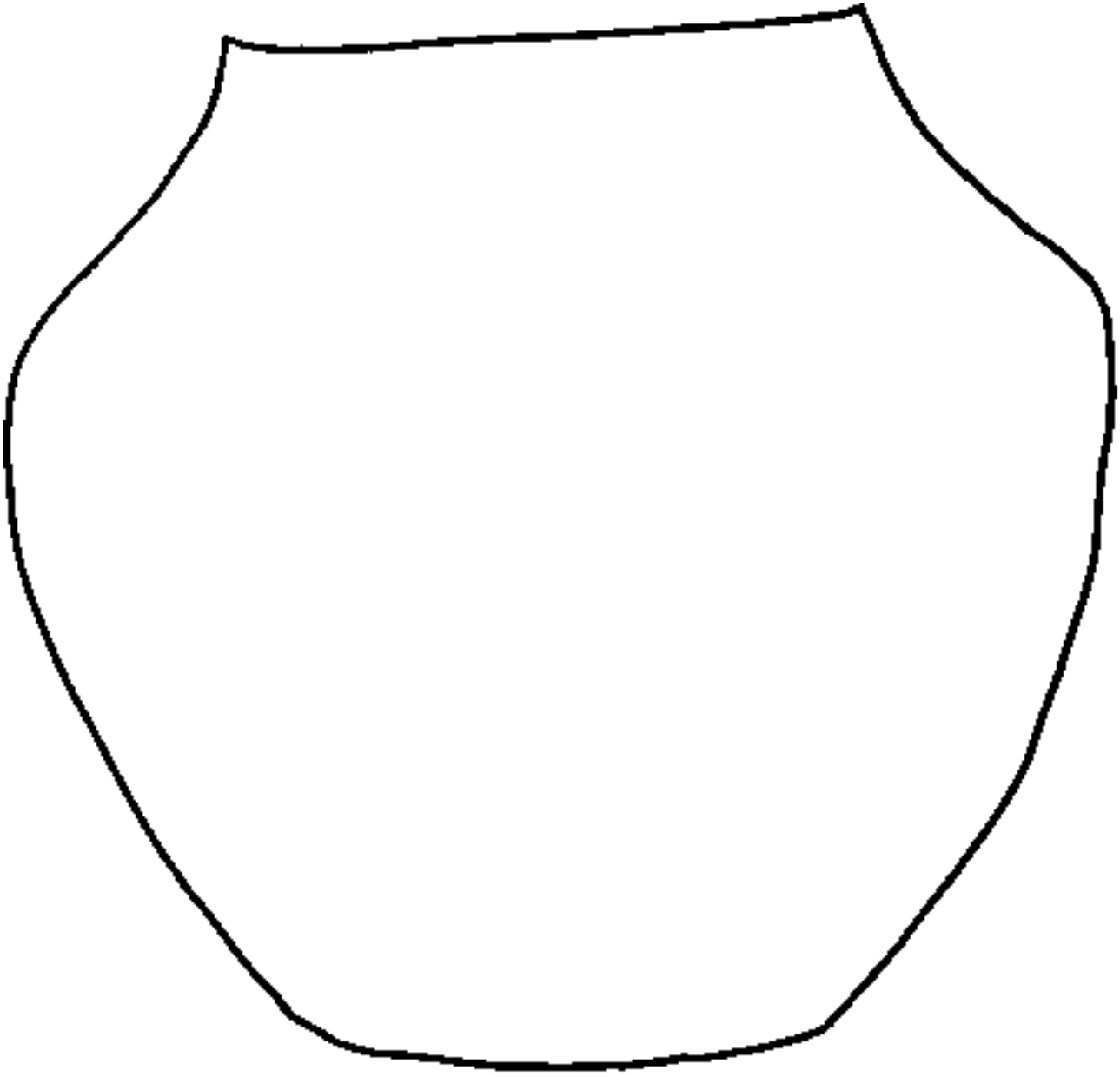
2 1/2 cups flour
1 cup salt
1 tablespoon powdered alum
4 tablespoons vegetable oil
1 1/2 cups boiling water

Mix together dry ingredients. Carefully stir in water and oil. When smooth, knead unil it feels firm.

Name:
Date:

When Clay Sings

Color the pot and cut it out. Cut the pot into 10 pieces (like a jig-saw puzzle). Take out one or two pieces and give the pieces to a friend and see if he or she can put it back together.



Think About It

1. Would it have been easier to put the pot together if you had all the pieces?

2. Why is it important to leave all artifacts where you find them?

Spanish Exploration

Subjects:
social studies
literature
creative writing

Skills:
creative writing
listening

Materials:
parchment, or other heavy paper
markers

Vocabulary Words:
expeditions

Objectives:

The student will be able to write a historically accurate journal entry from the viewpoint of an explorer.

Background:

Lured by tales of the Seven Cities of Gold, the Spanish began **expeditions** to this area about 1540. Several expeditions travelled past the lava flows, but very few actually traversed the rugged black rock. The first Spaniard to record his passage through the lava flows was Diego Perez de Luxan in the Spring of 1583. He wrote that he traveled "four leagues in waterless malpais."

Although the fabeled Seven Cities of Gold proved to be a play of light on mud and adobe buildings, the Spanish claimed the area for Spain. Several more explorers traveled through the area including Don Juan de Onate in 1604 and the friars Francisco Dominquez and Silvestre Velez de Escalante in 1776-1777.

Suggested Procedure:

1. Discuss the history of Spanish exploration in the El Malpais area.

2. Ask questions about what it might be like to be an explorer and to see this area for the first time.

3. Explain to students that they will pretend to be explorers coming to the El Malpais area for the first time. Have students write journal entries being as descriptive as possible. Students may want to write their journal entries on parchment, or other heavy paper and draw maps or pictures of what they see.

Homestead Challenge

Subjects:
social studies
math

Skills:
creative thinking

Materials:
worksheet

Vocabulary Words:
Homestead Act

Objectives:

Students will be able to relate to life as a homesteader in 1930s New Mexico.

Background:

The Stock Raising **Homestead Act** of 1916 offered land for a $34 filing fee. A family had to remain on the land for seven of twelve months for three years, make $800 worth of improvements and make a habitable home.

Times were hard, but families could find a living with local ranches. Work could also be found at a carrot farm near Bluewater or at the flourspar and pumice mines in the area.

Many families did not make it and had to move on. The remains of these homesteads can be found at El Malpais.

Suggested Procedure:

1. Group students into groups of four or five.

2. Discuss the history of homesteading in the Malpais area.

3. Use the worksheet as a guide to help students think about what life a homesteader was like.

Extension:

Prepare a typical homesteader meal and discuss where all of the ingredients would have come from (i.e., milk would most likely have come from the family's own cow).

A sample menu:
Cornbread
Beans
Milk
Chicken

Name:
Date:

Homestead Challenge

The year is 1932--the Great Depression has hit your family hard. They had to sell everything so they could move west in hope of finding a better life. New Mexico still had land open for Homesteading and for a $34 filing fee, your family will own 160 acres of land, providing you live on the land for seven months per year for three years and make $800 dollars worth of improvement in that time.

When you arrive at your new land, you see that there are tall sandstone cliffs and miles of black, rugged lava. Think about what your family will need to do in the first year that you live here. Think about how you will get supplies and food. What will your house be made of? Remember, your house will not have electricity or running water. The closest town is 40 miles away on a dirt road and the family car does not run well. To help start your new life in New Mexico, your family brought the following items:

Old car (does not run well)
Wagon
Horse
Milk cow
10 Chickens
Vegetable Seeds
4 Sheep
A few hand tools
$100

What improvements will you make the first year? In groups of four or five, assign rolls of familiy members. Have each person describe how they will help to make $800 dollars worth of improvments.

Think About it

What would you do for entertainment if you lived on a homestead in the 1930s? How would life be different? Do you think you would enjoy life as a Homesteader? Why or why not?

Mock Trial

Subjects:
science
social studies

Skills:
listening
creative thinking
making inferences
role playing

Materials:
scripted mock trial

Vocabulary Words:
plaintiff
evidence
prosecutor
defense attorney
witnesses
defendant
judge
bailiff
clerk
recorder
jury
Archaeological Resources Protection Act

Objectives

Students will be able to perform a mock trial about a violation of the Archaeological Resources Protection Act.

Background

The Southwest is rich in archaeological ruins. Because of the dry, arid climate these ruins, and artifacts associated with many of the ruins, have been remarkably preserved for hundreds of years. These ruins have been able to withstand the ravishes of time, but not of man. Archaeological sites are difficult to protect from vandalism and theft.

The Archaeological Resources Protection Act (ARPA) of 1979 was enacted "to protect archaeological resources on public lands and Indian lands, and for other purposes."

Suggested Procedure

1. Before students can perform the mock trial, they need to learn terms associated with trials. They should understand there are two types of trials: civil trials and criminal trials. The trial about a violation of ARPA would be a criminal trial.

2. Use vocabulary list (definitions are found in the glossary) to teach the terms associated with trials.

3. Select students to role-play the parts of the trial. Students not in the trial will be members of the jury. Remaining students will be spectators.

4. After the trial, discuss the trial results. Try to analyze why the jury made a decision of guilty or not guilty.

Extension:

Perform the trial for another class. Select the jury from that class.

Name:
Date:

Mock Trial

Case summery
Mr. Smith has been accused of violating several Federal laws and regulations. He allegedly committed criminal acts in violation of laws and attempted to conceal the violations and continued to violate Federal laws by soliciting the participation of others in criminal violations.

On or about August 15, 2___, Mr. Smith was seen hauling rock from a known archaeological site on Federal land. The witness did not recognize Mr. Smith, but did get a license plate number and reported it to the Sheriff's office. Subsequent to that report, Federal law enforcement officers began a surveillance of the archaeological site. The following Saturday, the above mentioned defendant was seen approaching the area in a large truck, with a license plate number matching the one reported by the witness. Mr. Smith was observed placing stone from the ruins in the back of the truck.

At this point, Mr. Smith was approached by Federal law officers and informed that he was in violation of Federal law. Mr. Smith claimed he was on private property, at which time Federal law officers read him his rights and made the arrest. The truck and its contents were impounded for evidence. A search of Mr. Smith's residence revealed the presence of materials whose origins were probably from the aforementioned archaeological site.

Mr. Smith was charged with violations of the Archaeological Resource Protection Act and a court date was set.

Players:
bailiff
judge
federal attorney
defense attorney
defendant
witness #1 for government
witness #2 for government
witness #3 for government
witness # 4 for defense
court reporter (optional)
12 jurors

United States vs John Smith

Bailiff: All rise, the Court of (insert Town or City) is now open and is in session, the Honorable Judge _____ (insert student name) presiding. All persons having business before the court come to order. Case of the United States vs John Smith. It is now time to swear in the jury. The jury will rise, raise your right hands and be sworn. "Do you solemnly swear that you will well and truly try the issues now to be given to you; that you will speak in hand, but among yourselves; nor will you suffer anyone to speak to you about the same but in court; and when you are agreed upon any verdict, you will keep it secret until you deliver it up in court? Do you all so swear?"

Jury: I do.

Judge: Does the Prosecution have an opening statement?

Prosecution: Yes, your Honor. (addressing the jury) Ladies and Gentlemen, we will show that on or about August 15 and August 22, 2___, the defendant, Mr. John Smith, took rock and material from a clearly marked archaeological site in blatant violation of the Archaeological Resource Protection Act. I know you will listen carefully to all the evidence we are prepared to present. Thank you.

Judge: Does the Defense have an opening statement?

Defense: Yes, your Honor. (addressing the jury) Ladies and Gentlemen, I believe that you will find the defendant not guilty. The evidence will show that Mr. Smith had reason to believe that the archaeological site in question was on private land and he had permission to be there and remove rock from the same.

Judge: Mr._____ call your first witness.

Prosecution: I call Ms._____(insert student's name)
(Witness takes the stand)

Bailiff: Raise your right hand. "Do you swear to tell the whole truth and nothing but the truth in this case under penalty of perjury, so help you God?" (Bailiff will repeat this for each witness)

Witness #1: I do.

Prosecution: State your name, where you live and what you do for a living.

Witness #1: Ms._____(insert student name). I live in Grants, New Mexico and I am an amateur photographer.

Prosecution: Have you ever seen the defendant, Mr. Smith, before?

Witness #1: I saw him driving a truck near a ruin site on Federal land. I go there often to take pictures. I saw the defendant on the afternoon of August 15. After seeing the truck, I reported the license plate number to the sheriff's office.

Prosecution: I have no further questions.

Judge: Does the Defense wish to cross-examine?

Defense: Yes, your Honor. Ms._____, you have stated that you saw the defendant on the afternoon of August 15, driving a truck near a ruin site. Can you describe what the defendant was wearing?

Witness #1: The sun was shining, so I could not get a good look at Mr. Smith and what he was wearing. Besides, he was inside of the truck.

Defense: So you did not actually get a good look at Mr. Smith. Someone else could have been driving, is that not so? I have no further questions.

Judge: (To the witness) You may step down. Prosecution call your next witness.

Prosecution: I call Special Agent _____ of the National Park Service.

Bailiff: (Swears in the witness)

Prosecution: State your name and occupation for the court record.

Witness #2: I am _____(insert student name) and work as a special agent investigating violations of the Archaeological Resource Protection Act on Federal land for the National Park Service.

Prosecution: Please tell the jury what you observed on August 22 of this year.

Witness #2: We received a report from the Sheriff's office of possible vandalism of a sensitive archaeological site located on Federal land. A surveillance of the site was set up on August 22, a truck was seen approaching the ruin site and the defendant got out of the truck and began loading rocks from the structures there. At this point, the defendant was approached and informed he was on Federal land. The defendant stated that he thought this was private land owned by his uncle. The defendant was read his rights and the arrest was made.

Prosecutor: I have no further questions.

Judge: Does the Defense wish to cross-examine?

Defense: Yes, your Honor. Mr._____is the area around the ruin site clearly marked as Federal land and protected by Federal law?

Witness #2: I believe so. There are signs marking the boundaries of land owned by the Federal government.

Defense: No further questions.

Judge: You may step down. Prosecution call your next witness.

Prosecution: I call Ms._____(insert student name)

Bailiff: (Swears in the witness)

Prosecution: State your name and occupation please.

Witness #3: My name is _____and I am an archaeologist.

Prosecution: I believe that you did a comparison of soil and rock samples taken from the ruins and soil and rock collected from the home of Mr. Smith. What were the results of that comparison?

Witness #3: The study showed similarities in both the soil and the rock taken from the ruin site and that taken from the home of Mr. Smith. Further, studies were done of soil found around the Smith home, and they were found to be considerably different in composition from that at the ruin site.

Prosecution: From this study then, would you conclude that the rocks and soil samples found at the Smith residence came from the ruin site?

Defense: I object your Honor. The Prosecution is calling for the witness to decide on my client's guilt or innocence. That is for the jury to decide.

Judge: Overruled, the witness may answer the question.

Witness #3: Based on the soil and rock samples studied, it is reasonable to conclude that they came from the same location.

Prosecution: No further questions.

Judge: Does the Defense wish to cross-examine?

Defense: Yes, your Honor. Ms._____don't all soils found in this part of the state have the same basic composition?

Witness #3: Well, yes. Rocks and soils can be so complex, that it can be difficult to pin point exact locations sometimes.

Defense: No further questions.

Judge: You may step down. Does the Prosecution have any more witnesses?

Prosecution: No, you Honor. The Prosecution rests.

Judge: The Defense may call its first witness.

Defense: The Defense calls Mr. _____(insert student name)

Bailiff: (Swears in the witness)

Defense: Please state your name, where you live and what your occupation is.

Witness #4: My name is _____, I live in Cibola County and ranch for a living. At least I do when the government leaves me alone.

Defense: Mr. _____,what is your relation to the defendant?

Witness #4: He's my nephew on my wife's side. Used to spend his summers out on the ranch when he was a kid. Loved to explore.

Defense: Did your nephew have any reason to believe that land in question was private land?

Witness #4: Why sure, I been running cattle out there for more than 30 years. I lease that land from the government, so don't that give me the right to what's there?

Defense: Thank you Mr. _____ .

Judge: Does the Prosecution wish to cross-examine?

Prosecution: Mr. _____does a grazing lease give you the right to destroy archaeological sites?

Defense: I object, your Honor. This witness is not on trial.

Judge: Objection sustained.

Prosecution: I withdraw my question. I have no further questions of this witness.

Judge: You may step down. Call your next witness.

Defense: I call the defendant, Mr. Smith, to testify.

Bailiff: (Swears in the witness)

Defense: Please state your name, where your live and your occupation.

Defendant: My name is John Smith. I live near Grants and right now I'm unemployed. I used to be a miner.

Defense: Mr. Smith, what were you doing on August 22, when Federal officers arrested you for allegedly violating the Archaeological Resource Protection Act?

Defendant: Well, I drove out to my Uncle's ranch to get a load of rocks to build a fence. I never knew that there land was protected by Federal law. I thought I was on private land, my uncle's land. If I'd of known that rock was so special, I'd of gone somewhere else for it. There's lots of rocks out there.

Defense: I have no further questions of this witness.

Judge: Does the Prosecution wish to cross-examine?

Prosecution: Yes, your Honor. Mr. Smith, did you at any time see signs posted, stating that this area was a protected archaeological site?

Defendant: Well, now maybe I did see one sign, but I thought it was for the land on the other side of the fence.

Prosecution: No further questions.

Judge: You may step down Mr. Smith. Call you next witness.

Defense: The Defense rests, your Honor.

Judge: Does the Prosecution have a closing statement?

Prosecution: Yes, your Honor. (addressing the jury) The Prosecution has shown that the defendant, Mr. Smith, did destroy an important archeological ruin. An eye witness saw him at the scene. Further, special law-enforcement agents from the Park Service saw Mr. Smith load rock from the ruin into his truck. Finally, soil and rock samples taken from the site and the Smith home prove without a doubt that Mr. Smith is guilty of violating the Archaeological Resource Protection Act. Thank you.

Judge: Does the Defense have a closing statement?

Defense: Yes, your Honor. (addressing the jury) Ladies and Gentlemen. The prosecution has not proven that Mr. Smith willfully destroyed an archaeological ruin. Mr. Smith thought he was on private property. Mr. Smith is a law-abiding citizen. He could have gotten the rock from anywhere. Thank you.

Judge: Ladies and Gentlemen of the Jury, the defendant in this case is charged with a criminal offense. In this country, a person is presumed innocent until proven guilty, beyond a reasonable doubt. In order to be proved guilty, the State must convince you that the defendant committed the crime. If you have any doubt in your mind that Mr. Smith committed the crime, then you must find him not guilty. The defendant does not have to disprove or prove anything. Ladies and Gentlemen, retire and consider your verdict.

The bailiff leads the jury out of the courtroom. The jury debates the quilt or innocence of the defendant. The verdict is written on a piece of paper. The bailiff is informed when the jury has reached a decision. The jury returns to the courtroom and court is resumed.

Bailiff: All rise, this court is now in session. The Honorable Judge_____presiding.

Judge: Ladies and Gentlemen of the Jury, have you reached a decision?

Jury: Yes, we have your Honor.

Judge: Please hand the verdict to the Bailiff. The defendant will rise and face the jury.

Bailiff: "We, the jury, find the defendant _____.

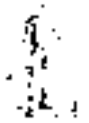
Judge: Court is adjourned.

Think About It

Do you agree with the jury's decision? Why or why not? What, if anything, could the loosing side have done to better argue their case?


Fire
THIMONI
2002

Fire History in El Malpais



All fires, whether they are started by humans or by natural causes require three elements in order to burn: heat, fuel and oxygen. These three elements together are known as the fire triangle. When a fire first starts, heat is the source of ignition--from lightning, or by human causes. Fuel is all of the trees, leaves, dry grass, pine needles and brush. Oxygen is found in the atmosphere. If any one of the elements is removed, the fire will not burn. Hot weather and winds can dry out fuels causing fires to spread faster. Fires, however, do not necessarily burn everything and can promote a healthy forest.

Fire is a natural part of any healthy forest ecosystem. Lightning ignited fires clear brush, pine needles and dead trees, returning nutrients to the soil. These fires also control disease and insect populations. Some species of trees require the heat associated with fire in order to reproduce. Without fire, forests become overgrown and unhealthy.

Among ponderosa pine forests, like those in El Malpais, light surface fires at frequent intervals are necessary and normal for a healthy ecosystem. In fact, many tree species have adapted themselves to periodic fires in order to survive. For instance, ponderosa pines have a fire resistant bark that will flake off if fire starts to ascend the tree. Only the dead or diseased trees will burn completely.

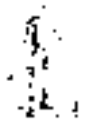
Tree researchers (dendrochronologists) can determine a great deal about past climate and fire histories based on data gathered from trees. Without adversely affecting a live tree, researchers can drill into the center of a tree trunk with a hollow instrument called a tree borer and remove a long cylindrical core sample. A slice of the trunk, a “tree cookie,” can also be cut if the tree is already dead. Dendrochronologists can then study the tree’s history preserved within the samples. Every year of growth, a tree adds a new layer of wood to its trunk creating rings throughout the trunk. Each ring represents one year in a trees’ life. Rainy years leave thicker rings than dry years. Seasons of fire leave scars on the tree marking the event for the future. Well-preserved fire scar samples found throughout the El Malpais area were used to develop fire chronologies for the past six hundred years. These tree rings showed researchers that natural fires occurred about every five to twelve years which kept surface fuel loadings low.

In the late 1800s, homesteaders began to move into the area. Their impact through logging activities and livestock grazing altered the landscape. Old growth ponderosa forests were logged allowing different species of trees such as pinon and juniper to move in. Because of the potential damage to homes and livestock, all fires were suppressed.

Complete fire suppression continued throughout the country until researchers began to realize the adverse affects. Ground fuels accumulated to dangerous levels and created hazardous environments. This made fires intense and hard to control when they did occur.

Today, El Malpais fire management teams work to restore the natural cycle of fire. They gather information about the fuel loadings in the area and monitor vegetative growth and disease. Management burns are conducted where fuel loadings have accumulated to dangerously high levels. Presuppression activities, such as tree limbing, are done to prevent major damage if a wildfire is started. Although a wildland fire can still occur anywhere at anytime, perhaps the destructive dangers can be controlled with today’s knowledge of the natural cycle of fire.

The Fire Triangle



Subjects:
Science
Language Arts

Skills:
creative thinking
making inferences

Materials:
worksheet
jar with lid
birthday candle
modeling clay
cup of water

Vocabulary Words:
ignition
element

This activity was adapted from *Project Learning Tree Curriculum and Activity Guide.*

Objectives:

Students will (1) name the three elements of the fire triangle (2) define the causes of fire (3) describe effective ways of putting out a fire.

Background:

Heat, oxygen and fuel are the three **elements** that make up the fire triangle. An increase in any of these elements will increase fire **ignition**; likewise, a decrease in any of the elements will diminish the fire. These increases and decreases can be naturally correlated with air and weather. They can also be affected by humans. Fire managers help prevent fires by reducing fuels so that fires will not start as easily or burn as intensely.

Suggested Procedure:

1. Using the Fire Triangle transparency, discuss the three elements that are necessary for a fire.

2. Pass out the "Fire Triangle" worksheet. Have students read and work through it on their own. When everyone is finished, discuss their answers.

3. Demonstrate how a flame burns in a glass jar when each of the three elements of fire are limited.

-Mount a birthday candle on a piece of clay and place in a jar.
-Discuss how the candle needs the three elements to burn.
- Light the candle, then seal the jar with the lid to cut off the supply of oxygen.
-Discuss how cutting off oxygen is one way of managing fire.

-Open the jar, relight the candle and put the lid back on.
-When the flame is almost out, pull the lid off.
-Discuss how this is what happens when the wind picks up during a fire.

-Leave the lid off and allow the candle to burn completely.
-Discuss how the fuel being completely used puts out the fire.

-Finally, replace the candle and light it.
-Extinguish the flame with water, which removes the heat.
-Discuss how with all of today's "high-tech" firefighting equipment, water is still the primary tool used to fight fires.

Name:
Date:

The Fire Triangle

1. Fires need heat, fuel and oxygen to burn—this is known as the "fire triangle." Draw a triangle below and label each of the three sides with the word or picture of heat, fuel and oxygen.

2. Name two natural sources of fire ignition:

3. Name two types of human-caused fire ignition:

4. Fires need fuel to burn. In a forest, what sort of fuels might you expect to find?

5. Where is oxygen found?

6. What can hot temperatures and dry winds do to create severe fire conditions?

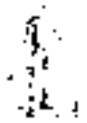
7. If you cut off any one of the three elements (oxygen, fuel, heat), a fire will not burn. What are some ways that firefighters might cut off each of the three parts of the fire triangle?

oxygen

fuel

heat

Habitats Classified



Subjects:
Science
Language Arts

Skills:
creative thinking
making inferences

Materials:
Fire's Role in Nature poster
worksheet

Vocabulary Words:
community
ecosystem

This activity was adapted from *The Wilderness & Land Ethic Curriculum.*

Objectives:

students will (1) identify animals and their suitable habitats (2) determine how fire affects habitat (3) state how animals adapt to fire.

Background:

Ecosystems can be defined as the **community** of living organisms, environmental factors and the natural processes that perpetuate the interactions of these features over time. Fire is one of the most dramatic processes of any ecosystem. An understanding of the role of fire in natural communities demonstrates that in some ecosystems the health of many communities is directly related to the burning of periodic fires throughout the long term history of an area.

Suggested Procedure:

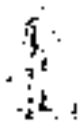
1. Introduce the poster "Fire's Role in Nature" and note that the presence of fire in natural communities creates a variety of habitats.

2. Identify the different animals and point out that they are illustrated in the habitats that best suit their needs.

3. Explain that these animals move between the mixture of habitats created by fires.

4. Have groups of students complete the worksheet "Habitats Classified." (Answers in order of listing: bluebird, hawk, moose, woodpecker, elk, chipmunk, bobcat, grouse.)

Name:
Date:



Habitats Classified

Read this classified section. In the space provided below each ad, write the name of the animal you think would most likely be found in this "residence." All the animals are pictured in the "Fire's Role in Nature" poster.

1. Cozy high rise apartment for summer, monthly lease. Convenient location on migration route.

2. Penthouse in burned forest provides comfortable nest site with great views of your neighbors. The hunting is great. Prey can run, but little cover in which to hide.

3. Marshy Meadow still has a few undeveloped sites with poor drainage on flood plain location. Tasty sedges and willows plentiful. Must see!

4. Trees! Trees! Trees! All burned! Crawling with insect larvae. Many homesites ready for immediate occupancy. Feed from your own doorstep!

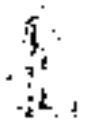
5. Recently burned area offers excellent foraging opportunities. Luxuriant undergrowth in open area. Good cover in forests nearby.

6. Do you like seed? This newly burned location still has good cover but more seeds than you could ever stuff into your cheeks. Don't delay; scurry in today!

7. Looking for a secluded den? Rocky Ridge Estates offers the privacy you need with superb year-round hunting nearby.

8. Medium age community with open space, sunshine and young evergreen trees. Fine dining on seeds and berries abounds. Excellent opportunity for occupants with camouflage coloring and ability to remain still.

The Scars of Life



Subjects:
Science
math

Skills:
making inferences

Materials:
copies of "tree cookies"

Vocabulary Words:
drought

This activity was adapted from *Project Learning Tree Curriculum and Activity Guide.*

Objectives:

Students will (1) infer from a tree's rings what damage or stress might have occurred in its life (2) determine an estimated age of their tree ring.

Background:

By counting a tree's growth rings, you can tell its age. Every year of growth, a tree adds a new layer of wood to its trunk. Each ring has two parts: a wide, light part (early wood) and a narrow dark part (late wood). The early wood grows during the wet, spring growing season. During the transition from the drier summer to fall and winter, the growth slows and the late wood forms. These rings provide clues about the past climate or weather of an area including **drought** or extreamly wet years. Dead branches and fire scars can also be seen in the growth rings of a tree.

Suggested Procedure:

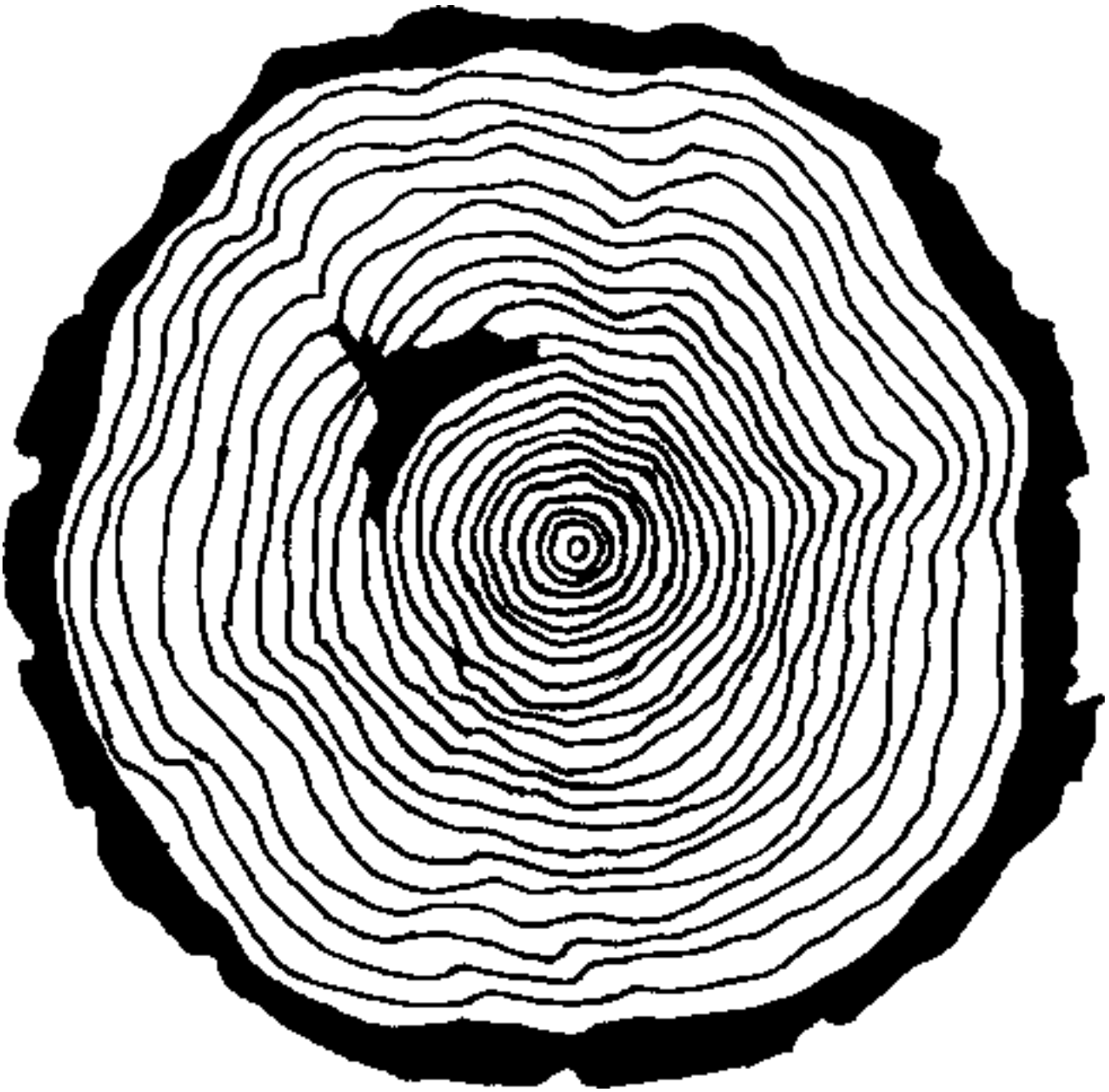
1. Divide the class into three groups. Discuss how tree rings are used to study the life of a tree.

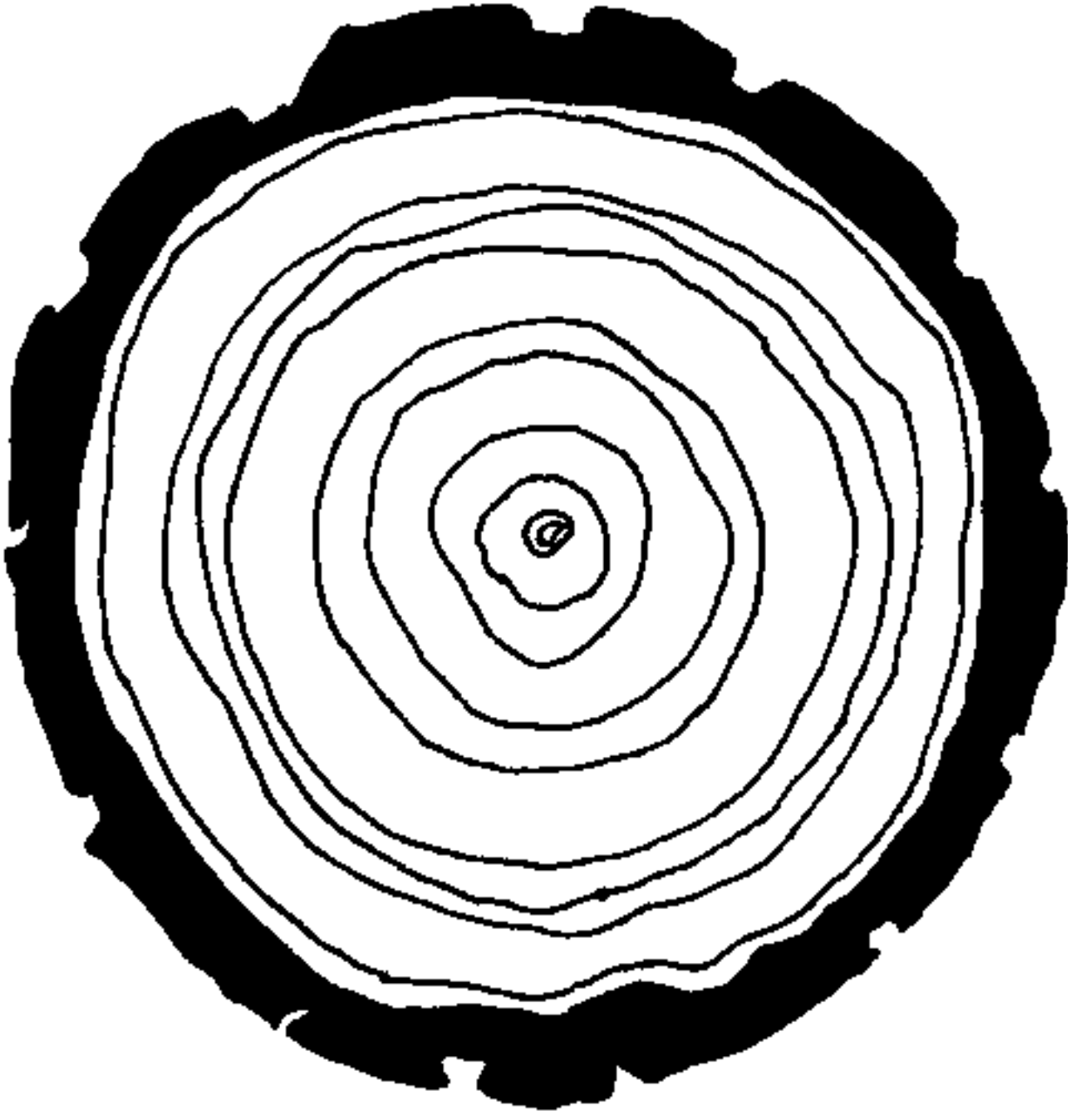
2. Give students different "tree cookie" handouts to each group.

3. Explain how to count the rings to find the age of their tree (counting only the light or dark rings).

4. Have each group estimate how old their tree was when it was cut and find evidence of past disturbances such as fire, insect damage or the loss of a branch.

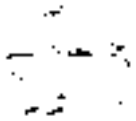
5. Each group can share their tree cookie with the class.






Explore

Exploring El Malpais



The following is a list of hiking areas that your class can explore anytime without a ranger. For a current list of ranger guided hikes, or help in planning a field trip to El Malpais, please contact El Malpais National Monument at 505-285-4641. Keep in mind that some of these hikes are rugged and not suitable for all age levels.

El Calderon Area

3 mile loop over varied terrain

This gravel and dirt trail leads students past a lava tube, sink holes, trenches, Bat Cave, and El Calderon Cinder Cone.This is a good place to look at how life adapts to lava terrain.

Junction Cave

¼ mile long lava tube

Just off the parking lot at the El Calderon Area, Junction Cave is a great place to explore a lava tube. Students and teachers will need to be prepared with water and flashlights and hard hats. Junction Cave is rugged and does require walking on uneven, rocky terrain.

Big Tubes Area

1 ¼ mile trail over very rugged terrain

The Big Tubes Area combines many aspects of El Malpais including volcanology and lava tube exploration in a wilderness setting. Explore both the above ground and below ground world of lava flows and discover how life adapts to this rugged environment. If you will be going into the lava tubes, both students and teachers will need to be prepared with water and flashlights and hard hats. This is a rugged hike. Access to this area sometimes requires high clearance, four-wheel drive vehicles and can be impassible at times.

Lava Falls

1 mile loop over lava flows

The Lava Falls trail lies on the youngest of the lava flows at El Malpais National Monument. This would make a great introduction or conclusion to a unit on volcanos.

Leave No Trace

Subjects:
writing
art

Skills:
creative thinking

Materials:
drawing paper
black markers

Vocabulary Words:
Leave No Trace

Objectives:

Students will be able to create a "color page" to reinforce the concept of responsible use of public lands.

Method:

Each student will design a color page for a book about responsible use of public lands.

Background:

Americans love their public lands. The national parks and forests that are found in America are unique to this country. We love our parks and forests so much, that we are literally "loving them to death." They can no longer absorb the traditional uses that they once could. We must rethink how to minimize impact on public lands.

"Leave no Trace" is a concept that is being adopted by many users of public lands. By following these simple guidelines, the outdoor experience as we know it today will be here tomorrow for others to enjoy and share:
Plan ahead and prepare
Camp and travel on durable surfaces
Pack it in, pack it out
Properly dispose of what you can't pack out
Leave what you find
Minimize use and impact of fires

Suggested Procedure:

1. Discuss or brainstorm ways people can take care of parks and forests. The Leave No Trace Land Ethics brochure may be helpful. List these on the board. Try to have at least one item for each child in the classroom.

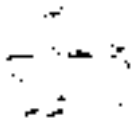
2. Have each student select an item from the board and make a drawing to illustrate what they have selected. Use black pen or markers so the pages can be copied.

3. Copy the pages and compile them in book form. Give one to each child.

Extension:

Part of leaving no trace of your visit is being prepared. Have students make a check list of items they need for their hike.

Interview a Tree



Skills:
observing
writing

Materials:
blindfolds
stethoscopes
white rice paper
charcoal sticks

Vocabulary Words:
characteristics
individualistic

This activity was adapted, with permission, from *Sharing Nature with Children* by Joseph Cornell

Objectives:

Students will be able to (1) identify a tree by using their senses of smell, touch, and observation and (2) write a booklet about a tree.

Background:

Trees, like people, display particular **characteristics** which make them **individualistic**. No two trees are exactly alike; even trees of the same species. Many factors affect a tree's life such as exposure to fire, plant disease, insect infestation, animal use, human influence, water, nutrients, sunlight and shade patterns. All of these elements comprise a tree's "personality" and health.

Suggested Procedure:

Note: This is a multi-part activity. The components can be used together or as separate activities. Some preparation will be needed before going into the field.

Part I:

1. Explain to students that trees are as individual as they are. Each species of tree has distinctive characteristics.

2. Working in pairs, one of the partners will blindfold the other and lead that person to a tree. The blindfolded partner will utilize all his/her senses to become acquainted with the tree. The blindfolded partner is led back to the starting point and the blindfold removed. The student will then try and locate his/her tree. This procedure is repeated using the other partner.

3. Using a stethoscope, listen to the tree's "heart beat".

4. Students can make a bark rubbing of their trees. Tape rice paper to the tree trunk and carefully rub the bark with the flat side of a peeled crayon or charcoal stick. Make a rubbing of the tree's leaves.

Part II:
1. Explain to students that they are to learn as much about their tree as they can by listening, smelling, touching and observing.

2. Give students a copy of questions they can try to answer about their tree. Students will use info they have gathered to write a story about their tree.

3. After returning to the classroom , compile all the information in book form with illustrations. (This may take several class periods). These stories can be fictional or fact. There would be some scientific information about the tree in both types of writing.

Extension:

Share the books with classmates. Take them to classrooms of younger children and share with them.

Name:
Date:

Interview A Tree

What does your tree look like? Write a description using as many descriptive words as you can.

How big is your tree? Is it small or very tall? Can you fit your arms around it? If it's too big for one person, how many people does it take to make a circle around your tree?

Is your tree young or old? How can you tell?

What kind of shape does your tree have? Why do you think it's shaped the way it is? Sketch a picture of your tree.

Can you see cones or berries or other fruits on your tree? Are there any seeds? Don't forget to look on the ground.

Draw a picture of the fruit or seeds.

What is the bark like? How does it feel? What color is the bark?

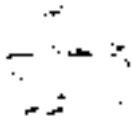
Describe how the leaves look (remember the needles on evergreen trees are leaves). How do they feel? Smell? Draw a picture of your tree's leaf.

Are any other plants growing on your tree? Look for lichens, moss, fungus, mistletoe. Describe them.

Are there any signs of animals around or on your tree? Have there been insects or other creatures eating or using your tree?

What kind of life has your tree had? Are there broken branches? Has lightening ever struck your tree?

Tracks!



Subjects:
science
art
language arts

Skills:
analysis
comparing
application
writing

Materials:
spoons
cups
plaster of Paris
plastic spray
milk cartons
Vaseline
black poster paint or India ink

Vocabulary Words:
evidence
track

This activity was adapted, with permission, from *Project WILD K-12 Curriculum and Activity Guide.*

Objectives:

Students will be able to locate and identify common animal tracks.

Background:

Animal **tracks** are a fun and easy way to learn about the animal life in an area. They are **evidence** of activity in an animal community. These tracks are easy to find in sandy places or in mud near water. Larger animal tracks are often found in open areas, smaller animals leave tracks near bushes or cover of some kind. Tracks can be preserved by making plaster casts of them. Knowledge of an ecosystem is greatly enhanced by knowledge of who lives there.

Suggested Procedure:

1. Divide students into small groups to find tracks. Remind students to be careful of where they step. A careless step could wipe out animal tracks.

2. Once a track is found, clean it of loose particles of soil, twigs, leaves, and other litter.

3. Spray the track with shellac or plastic sealant from a pressurized can to seal the track.

4. Form a two-inch wide strip of cardboard into a ring surrounding the track. Press the cardboard ring firmly into the ground to give support, leaving at least one inch above ground to mold for the plaster. One of the easiest ways to make a mold is to cut plastic two-liter soda bottles or paper mild cartons in half. Cut both the top and bottom from a tuna or cat food can or a plastic margarine tub to make simple round molds. Stapled strips of cardboard in the shape of a circle also can be used.

5. Mix about two cups of plaster in a container, adding water slowly until it is about as thick as heavy cream. Carefully pour the mixture into the mold until the plaster is almost to the top. Allow the plaster to harden at least 15 minutes before lifting it out of the track. If the soil is damp, the plaster may take longer to harden.

6. When the cast is hard, lift it out and remove the ring. Clean the cast by scraping it with a knife blade or toothbrush and washing. Please note that you may need to wait a few hours to ensure that the cast is sufficiently dry.

7. To make a reverse image of the track, apply a thin coating of petroleum jelly to the track and surface of the the cast. Place the animal cast on a flat surface and surround the cast with a two-inch strip of cardboard as before. The original cast now becomes the mold.

8. Mix the plaster and pour it into the mold, making certain that the top surface of the casting is smooth and level with the mold. If you plan to use the casting as a wall plaque, place a loop of wire in back of the casting while the plaster is still soft. Allow two hours for the plaster to harden. Discuss different ways of recording animal tracks--photos, drawing, plaster, etc.

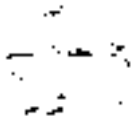
9. Carefully remove the mold when the plaster is dry. Separate the two layers and wipe the excess petroleum jelly from the face of the cast and track. Scrape any rough places with a knife blade or use fine sandpaper to smooth the surface. Wash the completed cast with water.

10. When the cast is throughly dry, paint the inside of the track with India ink or black poster paint. Label each each cast wit the name of the track and the student's name. A coat of clear shellac or clear plastic may be applied to protect and preserve the casting.

Extension:

Write a story about the animal that made your track. Find out as much as you can about that animal.

Homestead Hunt



Subjects:
science
social studies
language arts

Skills:
observing
categorizing
make inferences

Materials:
clipboards
paper
pencils

Vocabulary Words:
homestead
homesteaders
artifacts
homestead laws

Objectives:

Students will be able to (1) draw conclusions about homestead life based on surface artifacts and (2) determine which artifacts might have been used by the homesteaders and which ones have no relation to the homesteaders.

Background:

Vast stretches of land in the American West lay open and was seemingly uninhabited. Such was the perspective of the American East. In reality, it was a land occupied by American Indian tribes who claimed it. The Indian tribes had no concept of legal ownership of land. The eastern Americans, of European descent, did not understand the American Indian concept of non-ownership. The law makers in Congress (all of European descent) felt the land of the west was there for the taking. The first Homestead Act was enacted in 1862.

The homestead laws were a collective name for a series of laws that allowed individuals to acquire land without capital. It provided that anyone who was either the head of a family, 21 years old or a veteran of 14 days of active service in the United States armed forces and who was a United States citizen or had filed a declaration of intent to become a citizen, could acquire a tract of land in the public domain not to exceed 160 acres. To acquire land, the **homesteader** had to settle on or cultivate the **homestead** for seven out of ten years. Largely because the supply of public land suitable for homesteading was exhausted, remaining public lands were withdrawn from homesteading in 1935.

The western part of New Mexico was one of the last areas left open to homesteading. The devastation of the Dust Bowl and the Depression of the 1930s forced thousands to leave their homes and farms. Some made their way to lands along the edge of the lava flows of El Malpais.

While it was a very difficult life--no electricity, dirt roads, no medical services, water shortages, etc., determined individuals tried to earn a living by farming and ranching. Like the Puebloan ancestors before them, they too passed on and left behind **artifacts** of their struggle to survive.

Suggested Procedure:

1. Take students to a homestead site. Students should be familiar with the Homestead Act and its provisions.

2. Allow student teams to explore the area, making an inventory of all ground structures and artifacts.

3. Students should separate the items on their lists according to use and try to determine what homesteaders may have used and what was dumped after they left.

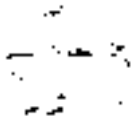
4. Reassemble teams and have them share their findings and conclusions.

5. Discussion questions: Who left these artifacts? Are all of the artifacts from the same time period? What would you be able to find out about the homesteader's life if there were no artifacts?

Extension:

Have student teams prepare a menu for a homesteader's typical day. They should remember there was no refrigeration, but consider animals that might be on a farm. Share menus. If possible, prepare a meal for the class to eat.

Picture That!



Subjects:
science
art
drama

Skills:
observing
remembering

Materials:
drawing paper

Vocabulary Words:
lava tube caves
collapses
sink holes
pahoehoe
aa
presure ridges

This activity was adapted, with permission, from *Sharing Nature with Children II* by Joseph Cornell

Objectives:

Students will be able to identify volcanic features.

Background:

The lava flows of El Malpais vary in age from 3000 years old to over 115,000 years old. **Lava tube caves**, **collapses**, **sink holes**, **pahoehoe**, **aa** and **presure ridges** are just some of the lava flow features found at El Malpais. The area is among the youngest volcanic regions in the Continental United States.

Suggested Procedure:

1. Divide students into pairs. Each pair must work on the buddy system, being careful to guide each other around dangerous places.

2. Explain that they have been asked to take photographs for a park pamphlet about the lava features in the monument. Each team member will take turns being camera and photographer. Photographers will select the snapshots, but the cameras will record the picture in their memories.

3. The camera will have his/her eyes closed while the photographer looks for a good snapshot. The photographer should let the camera know if the picture is a close-up or long distance image. When the photographer taps the camera's head, the camera will open his/her eyes for the snapshot.

4. Each photographer should take 5 snapshots, then switch places and become a camera.

5. After pictures are taken, discuss what the camera and photographers saw. What sort of things did they see? What kind of lava features were selected? Did they look at things differently as a photographer? As a camera?

Extension:

Have the students draw a picture of one of the snapshots recorded as a camera.


America's
Treasures

Your National Parks

In 1872, the United States Congress set aside a large area of land and named it Yellowstone National Park. Forty-four years later, in 1916, the National Park Service was created to manage Yellowstone and the other park units that had been established between 1872 and 1916. Today, the National Park Service manages over 380 units in the National Park System. These park units encompass everything from vast National Parks whose scenic beauty is breathtaking, to National Monuments that capture priceless pieces of America's natural and cultural history, to National Recreation Areas where we go to have fun in beautiful natural settings. There are many types of National Park units–from National Historic Sites to National River Ways–all of which have special significance and must be cared for accordingly.

If you have ever been to a National Park unit, you may have noticed some things you are not supposed to do. Activities like hunting and wood gathering are almost always not allowed in National Park units. Collecting of rocks, flowers or other natural and cultural items is also not allowed. Why? When the National Park Service was established in 1916, Congress said that the mission of the Park Service is "to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." In simpler terms, the job of the Park Service is to protect everything inside the parks so it will be preserved for future generations, while at the same time allowing the public to enjoy these parks. This mandate to provide enjoyment and access while leaving the parks unimpaired for future generations is often times not an easy job. There is a fine balancing act between protection of the land and enjoyment of the same.

We know that we are not supposed to do certain things in National Parks so that future generations will be able to enjoy the same things we do. So, what can you do in a National Park? Lots! You can hike a trail, smell the flowers, take a picture, touch a rock, learn about history, wonder about the future, view the wildlife, connect with nature, swim with the fish, listen to stories, see where dinosaurs roamed and where antelope play, gaze at the stars, discover something new or explore something old–the list is endless!

National Park units protect many aspects of America including ancient ruins, colonial homes, civil war and revolutionary war battle sites, civil rights and women's rights history, vast canyons, towering mountains, rivers, lakes, seashores, deserts and volcanos just to name a few! All the things that make America special, things that we treasure, are represented in the National Park System.

Explore Your Parks

Subjects:
social studies
writing

Skills:
writing
research

Materials:
worksheet
research materials

Objectives:

Students will be able to obtain information on National Parks and share what they have learned with others.

Background:

Park names and addresses can be found on the National Parks fold out map.

Suggested Procedure:

1. Have students gather information about a National Park unit of their choice either by mail or on the Internet.

2. They may use the worksheet and then give a short presentation to the class about their National Park unit.

Extension:

Have students create a poster or backboard using the information they receive that can be displayed for the entire school.

Name:
Date:

Explore Your Parks

You have been given a mission to explore a National Park unit. Before you go, however, you must learn as much about the area as you can. To do this, you must write to a National Park unit of your choice (your teacher will have a list of park names and addresses) and ask for any information they may be able to send you. Try to pick an area that you have never been to before and that you know nothing about. Remember, there are over 380 units to choose from! If you have access to the Internet, you can look up information on www.nps.gov.

When you have received the information in the mail, study everything that your park unit sent to you and answer the following questions. You may want to share what you learned with your class.

What is the name of your National Park unit?_____

Where is it located?_____

What are two things you think are special about your park unit?_____
_____

What kinds of things can you do at your park unit?_____
_____

When was this park unit established? (Information may not be available.)_____
_____

What are two questions you would like to ask about this park unit? (You do not have to answer.)
_____
_____

If you had the opportunity, would you like to visit this park unit? Why or why not?
_____
_____

Word Search Challenge

Subjects:
social studies

Skills:
map reading
research

Materials:
National Parks Map
worksheet

Objectives:

Students will become familiar with the location of National Parks.

Background:

List of Parks

Suggested Procedure:

1. Provide a list of the park names and locations or allow students to study the National Park fold-out map.

2. Remind students that all the areas on the word search are National Parks rather than National Monuments, National Historic Sites, etc.

Name:
Date:

Word Search Challenge

Hidden in the letters below are the names of 31 National Parks in the National Park System. The names may be up, down, backwards, forwards or diagonal. As you find the names, fill in the state in which they are found on the line provided. You may need to look at a map of the U.S. that has National Park units labeled. (Hint: these are all National Parks, not monuments, historic sites or other types of park units that you have learned about!)

G S T B S E O N A C L O V I I A W A H G B
A A I O U Q E S M O D N X O C P I N W E Y
L Y C R A T E R L A K E C F L D E Z X V N
X E Y I D S B D N E B G I B A M I P D T I
G L V B P Q J I V S J D N C X H S S B E A
T L W I V M W M N O Y N A C S G N I K V T
S O G S D T Y B R Y C E C A N Y O N T E N
E W Z J Q S D L V Q D O L P I G D T P R U
R S N I A T N U O M Y K O M S T A E R G O
O T E Y O S E M I T E G V H J L Q K L L M
F O V W I N D C A V E J N O P H S A H A Y
D N A I S L E R O Y A L E T X T C V A D K
E E C A N Y O N L A N D S S Q I G S L E C
I M H H A O D N A N E H S P E U Q P E S O
F T T O N O Y N A C D N A R G T S B A B R
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R I M E S A V E R D E H G N P H T B A S T
T R M B S D N A L S I N I G R I V V L R H
E D A S N R E V A C D A B S L R A C A Q U
P G M O U N T R A N I E R H I L A N E D S

Denali, ____
Grand Canyon, ____
Petrified Forest, ____
Hot Springs, ____
Sequoia,____
Kings Canyon, ____
Yosemite, ____
Lassen Volcanic, ____
Mesa Verde, ____
Rocky Mountain, ____
Everglades, ____
Hawaii Volcanoes, ____
Haleakala, ____
Yellowstone, ____
Mammoth Cave, ____
Acadia, ____
Isle Royale, ____
Glacier, ____
Carlsbad Caverns, ____
Smoky Mountains, ____
Crater Lake, ____
Wind Cave, ____
Big Bend, ____
Bryce Canyon, ____
Zion, ____
Canyon Lands, ____
Shenandoah, ____
Virgin Islands, ____
Mount Ranier, ____
Olympic, ____
Grand Teton, ____

National Park Crossword

Subjects:
social studies

Skills:
listening
remembering

Materials:
crossword puzzle

Objectives:

Students will be able to remember a basic history of the National Park Service and El Malpais.

Background:

Words in **bold** are the answers to National Park Crossword questions.

Yellowstone was the very first National Park; it was established in eighteen seventy-**two**. Since then, there have been many units added to the National Park System. They are found in every state in the Union except **Delaware**. From the 3.5 million acres of **Death Valley** National Park in California, to the .02 acre of **Kosciuszko** National Memorial in Pennsylvania, park units come in all sizes!

Some of these National Park units are right here in New Mexico. The first national monument in New Mexico was **El Morro** National Monument, established in nineteen hundred and **six**. It was established at the same time as **Devil's Tower** National Monument in Wyoming, but Devil's Tower has bragging rights as the first national monument because it comes first in the alphabet!

Another National Park unit found in New Mexico is El Malpais National Monument. Meaning "the badlands" in Spanish, El Malpais was established in nineteen eighty-**seven** to protect the lava flows and all the plants and animals found at El Malpais. The black rocks found at El Malpais are lava rocks that came from many different volcanoes. The youngest volcano, **McCartys** Crater, is only 3000 years old–very young in geologic time! Many interesting things can be found at El Malpais including **lava tubes**, which are caves created by lava flows. **Junction Cave** is one lava tube that you can explore at El Malpais. If you are lucky, you many even see a **troglobite**–an animal or insects that lives in the total darkness of a cave.

Suggested Procedure:

1. Read or provide the background information to the students.

2. Have students complete the crossword puzzle.

Name:
Date:

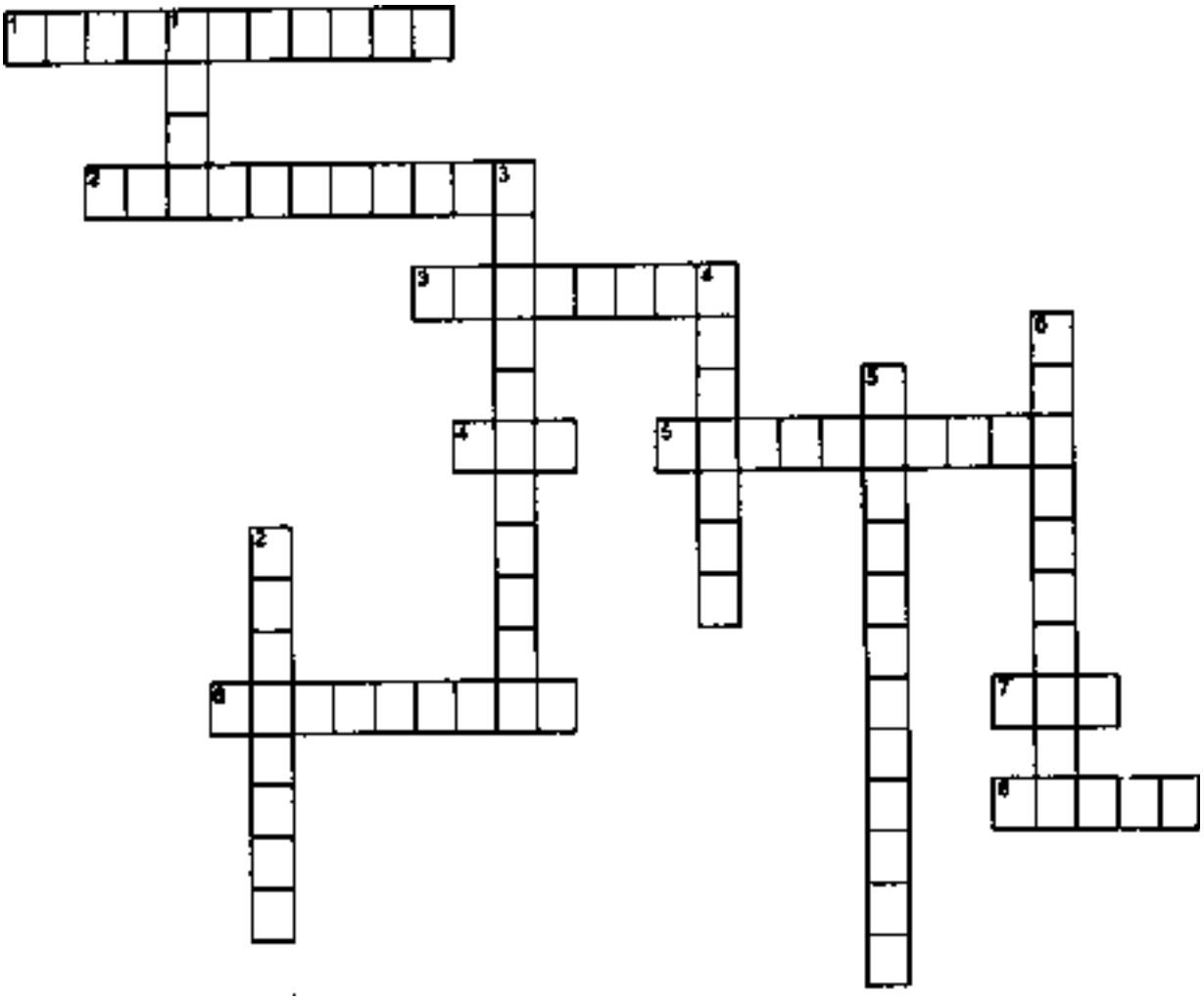
National Park Crossword

Across

1. The first National Monument.
2. The National Park unit with 3.5 million acres.
3. The only state without a National Park unit.
4. Yellowstone National Park was established in eighteen seventy-_____.
5. _____National Memorial is only .02 of an acre.
6. Caves created by lava flows are called _____.
7. El Morro National Monument was established in nineteen hundred-_____.
8. El Malpais National Monument was established in nineteen eighty-_____.

Down

1. The black rocks you see at El Malpais are _____rocks.
2. The youngest volcano at El Malpais is called _____ Crater.
3. The first National Park.
4. The first National Monument in New Mexico.
5. _____ is a lava tube cave you can visit at El Malpais.
6. You might find one of these in Junction Cave.



Create A Park

Subjects:
social studies
science

Skills:
creative thinking
cooperation

Materials:
worksheet

Vocabulary Words:
development
endangered species
extinction
habitat
migrate
preserve
resources

Objectives:

Students will gain a greater understanding of issues that the National Park Service faces and be able to brainstorm solutions to those problems.

Background:

Every year, millions of people visit the national parks. The push to make improvements on park lands is a real and daily issue for many parks. The problem parks' face is how to make improvements while still **preserving** the natural and cultural values of the area.

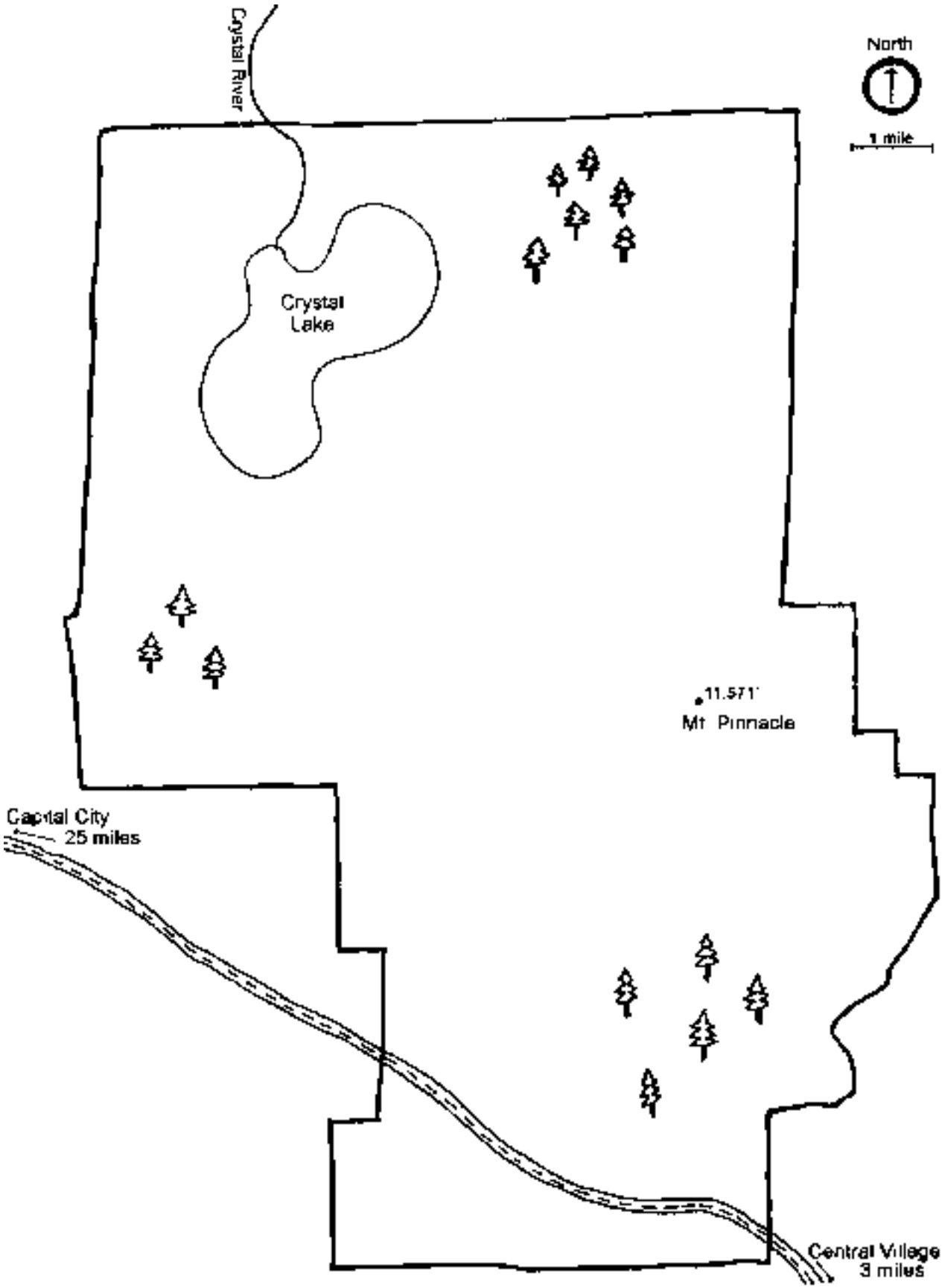
Suggested Procedure:

1.You may want to divide students into groups. Remind students to consider the needs of both the **resources** and the visitors as they are developing their park. Ask questions such as are two campgrounds needed? If so, how will another campground affect the animals, plants, water and landscape of the park?

2. Give each student a copy of the map and have them place all the items on the map.

3. After students have placed all the items on the map, tell them that a researcher has discovered an **endangered species** of bird in the park. The Great Blue Billed Crane uses the park in the warm summer months and has been found primarily around Crystal Lake. The Cranes have also been found in great numbers along a narrow corridor from Crystal Lake to the southern boundary of the park as they **migrate** south for the winter. Have students cut out the Great Blue Billed Crane Habitat and put it on their map (be sure to do this after students have placed all the other items on their maps).

4.The Great Blue Billed Crane is in immanent danger of **extinction**. Ask students what affect their decisions on park **development** now have on this bird. Are there major areas of development in the crane's **habitat**? If they knew about the Great Blue Billed Crane beforehand, what would they have done differently? What will they now do to ensure survival of the Great Blue Billed Crane?


Crystal River
North
1 mile
Crystal Lake
11,571'
Mt Pinnacle
Capital City
25 miles
Central Village
3 miles

Name:
Date:

Create A Park

Each year, more and more visitors come to the National Parks. In 1904, there were eleven National Parks. The visitation that year was 122,594 people. In 1998, there were over 370 units in the National Park System. Visitation reached 286,739,115 people. Despite the increase in visitation, park managers must preserve and protect the resources while allowing for public enjoyment.

Pretend that you are the Superintendent or Management Team of a new National Park unit. This new National Park includes a pristine mountain lake, aspen and pine groves, beautiful scenery and numerous plant and animal species, some found nowhere else on earth. Your job as the new Superintendent is to develop the park in a way that preserves the natural resources, while allowing the public to enjoy the land.

Cut out the objects below and paste them onto the map provided. Draw the roads and trails where you want them. You must have at least one road in the park (not including the one already there) and at least two trails. Think carefully about your choices. How do your decisions affect the resources? How do they affect visitors to your park?

You must use all of these items:


Visitor Center


Camp Ground


Restrooms


Trail Head


Trail Head


Picnic Area

These items are optional:


Boat Ramp

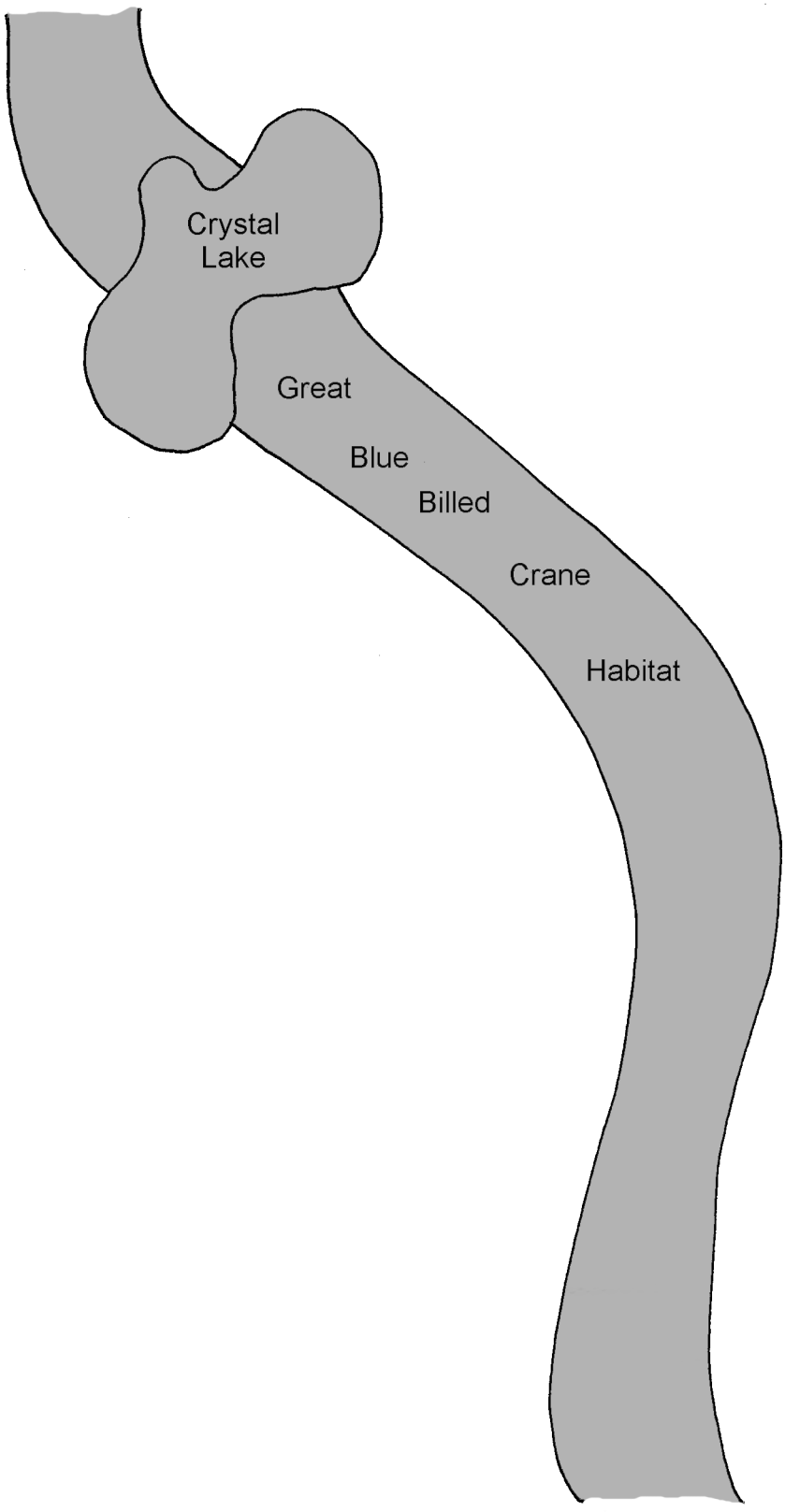

Restrooms


Picnic Area


Camp Ground

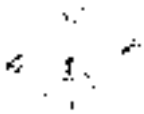

Ranger Station


Trail Head


Crystal
Lake
Great
Blue
Billed
Crane
Habitat

Appendex

Glossary



A

aa–A Hawiian term for lava flows typified by a rough, jagged surface.
adapt–the gradual process of adjustment to new physical conditions exhibited by living organisms.
archaeology–The study of human antiquities.
Archaeological Resources Protection Act–Congressional act that serves to protect archaeological resources on public and other lands.
artifacts–An object made by humans.
ash–Fine pyroclastic material.

B

bailiff–A court officer.
basalt–A dark colored igneous rock.

C

caldera–A large bowl shaped volcanic depression.
characteristics–The qualities making up an individual.
cinders–Volcanic fragments, ranging in size from ½" to 3", that fall to the ground in a solid condition.
cinder cone–A type of volcano ranging in height from about 20 feet high to 1,500 high or higher. Cinder cones are formed by the accumulation of cinders around the volcanic vent.
clerk–employee of the court who keeps court records.
collapses–Areas where the crust of the flow has fallen inward creating depressions.
community–A group of plants or animals living in the same area under more or less similar conditions.
composit volcano–a volcano formed by layers of ash, cinders, bombs, mud flows, and lava flows. Eruptions can be very violent. Also known as strato volcanoes.
control–A standard of comparison for checking or verifying the results of an experiment.
crater–a bowl shaped depression at the mouth of a volcano.

D

defendant–One against whom an action is brought.
defense attorney–A defendant's legal council.
development–To make more available.
drought–A long period with little or no rain.

E

echolocation–The ability of an animal, such as a bat, to orient itself by the reflection of the sound that it has produced.
ecosystem–An ecological community with its physical environment, regarded as a unit.
endangered species–A species of animal that is threatened with extinction.
element–one of the individual parts of a whole.
evidence–The documentary or verbal statements and material objects admissible as testimony in a court of law; signs or proof of existence.

expedition–A journey undertaken for a specific purpose.
extinction–No longer existing.

F

G

H
habitat–An animals home that contains all the basic necessities for life: food, water, shelter and space.
homestead–Land claimed by a settler.
homesteader–A person who settles and works the land of a homestead.
homestead law–Any of several laws passed in most states exempting a householder's homestead from attachment or forced sale of to meet general debts.
hot spot–An area where magma rises up and melts a hole through a plate in the earth's crust forming a volcano.
hypothesis–An explanation accounting for a set of facts that can be tested by further investigation.

I
ignite–To set fire to.
impacts–To have an effect on.
individualistic–Separate or distinct existenc.
interdependence–Mutually dependent.

J
judge–A public official authorized to hear and decide cases brought before a court of law.
jury–A body of persons sworn to judge and give verdict on a given matter in a court of law.

K

L
lava–Molten rock that is formed from a volcanic vent or fissure.
lava tube cave–Caves formed along a tube system when collapses occur that provide access to parts of the lava tube.
Leave No Trace–A set of land-use ethics create to help protect natural resources.

M
magma–Molten matter beneath the earth's crust.
mantle–The layer of earth between the crust and the core.
melanism–Darkness of the skin due to pigmentation.
migrate–To move seasonally from one region to another.

N

O

P

pahoehoe–Hawaiian term for relatively smooth surface or ropy textured lava.
pigmentation–Coloration of tissue by pigment.
plaintiff–The party that institutes a suite in court.
pottery sherds–a broken fragment of pottery often found on the ground near ruins.
predator–An animal that lives by preying on others.
preserve–To maintain unchanged.
pressure ridge–Ridges of lava formed by lateral pressures, similar to creating a fold in a piece of paper by pushing in towards the middle from both sides. Almost always has a large crack running down the crest.
prosecutor–A prosecuting attorney.
pyroclastic–Volcanic eruptions that are combinations of gas, ash, and rock that explode violently out of the volcano.

Q

R

rift zone–A place where the plates of the earth's crust split apart allowing magma to rise to the surface.
recorder–An employee of the court who records the proceedings.
resources–All of the natural and cultural items in a park.

S

sink holes–A collapsed lava tube where the walls are horizontal and circular in shape.
shield volcano–A rounded or flat topped volcano that is made up of multiple lava flows.
species–An organism belonging to a specific category.
stratigraphy–The study of rock layers and their contents.
subduction zone–An area where the earth's plates bump into one another and one slides below the other allowing magma to rise to the surface.

T

trogloxenes–A group of cave life that uses the cave, but is not dependent on it for survivial.
troglophiles–A group of cave live that lives their entire lives in the cave, but the same species can be found on the surface.
troglobits–A group of cave life that has adapted to life in complete darkness and depends upon the cave and its resources for survival.
track–A mark left on the ground by the foot of an animal.

U

V

viscous–Having a heavy, gluey quality.
viscosity–The degree to which a fluid resists flow under an applied force.
volcanic bombs–Rounded lava that has been thrown through the air by a volcano.

W

witness–One who is called upon to testify before a court.

X

Y

Z

References

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Useful Web Sites

National Park Service - www.nps.gov

U.S.D.A. Forest Service - www.fs.fed.us

Bureau of Land Management - www.nm.blm.gov

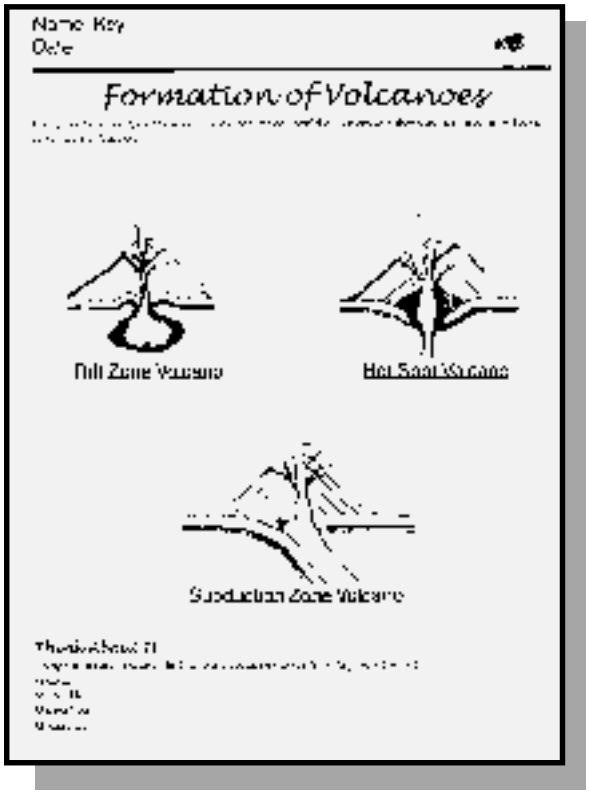
Items Available from El Malpais National Monument

Lava rock samples may be checked out from the Interpretation and Visitor Services Divistion at El Malpais Headquarters. Call 505-285-4641 to make arrangements.

The books in the park library are also avialable for you to check out. El Malpais Headquarters is located at 123 East Roosevelt Avenue and is open from 8:30 to 4:30 Monday through Friday.

There are several teaching aids available for you to purchase at the El Malpais Information Center located 23 miles south of Grants on NM 53 and at the Northwest New Mexico Visitor Center located at 1900 East Santa Fe Avenue in Grants. Both locations offer a 20% teacher discount.

Answer Key



Name: Key
Date:

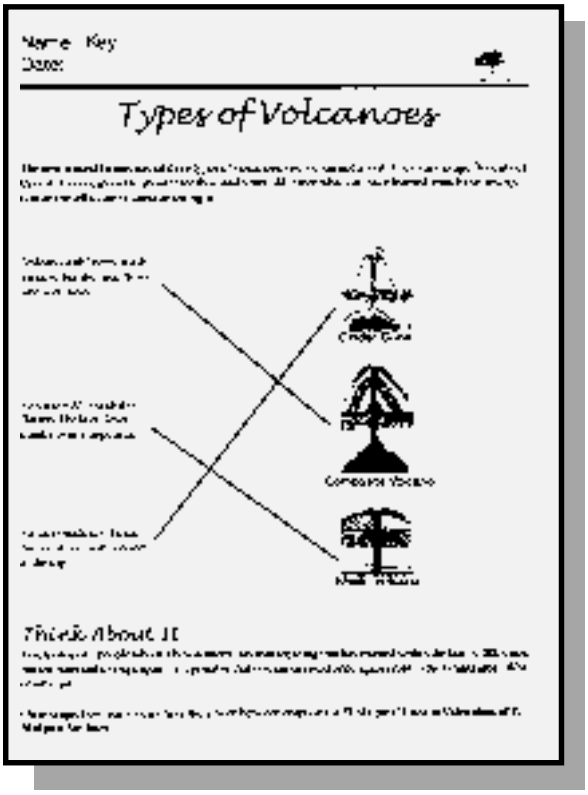
Formation of Volcanoes

Rift Zone Volcano

Hot Spot Volcano

Subduction Zone Volcano

Think About It



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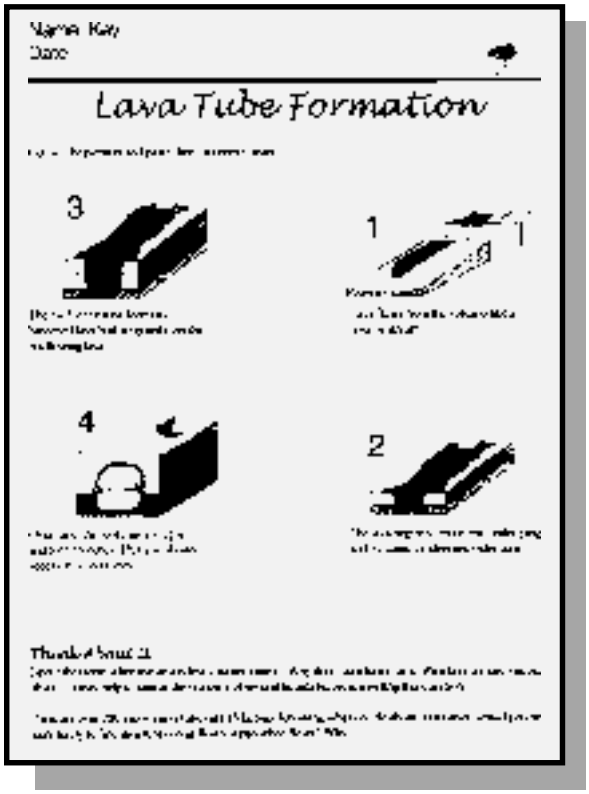
Types of Volcanoes

Composite Volcano

Think About It



Name: Key
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Lava Tube Formation

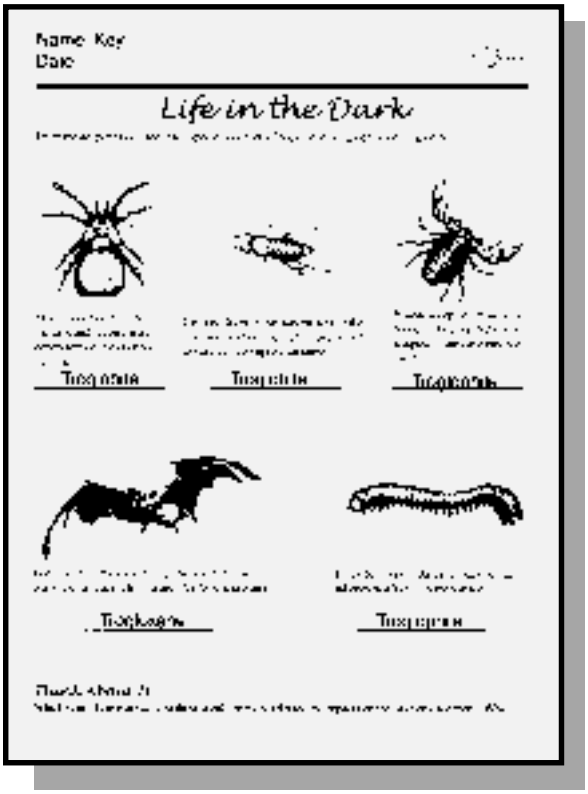
3

1

4

2

Think About It



Name: Key
Date:

Life in the Dark

Troglobite

Troglobite

Troglobite

Troglobite

Troglobite

Think About It

Name: Key
Date

The Fire Triangle

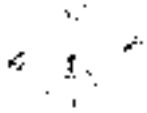
Name: Key
Date

Word Search Challenge

Name: Key
Date

National Park Crossword

Evaluation



Thank you for using Malpais Mysteries Curriculum Guide. We hope that it has been a useful teaching tool and that both you and your students enjoyed the activities.

If you have any ideas, suggestions or corrections that will help us improve this guide, please let us know. Your thoughts are important to us! Please return this form to:

Chief of Visitor Services
El Malpais National Monument
123 East Roosevelt Avenue
Grants, NM 87020

Fax: 505-285-5661

You may also want to include a photocopy of the activity or activities on which you are commenting.

Were the activities useful?

Were they age appropriate?

Was the guide easy to use?

Can you suggest any ways to help improve this guide?